# THE
# SURGICAL CLINICS
## *OF*
# NORTH AMERICA

*DECEMBER 1941*

*VOLUME 21—NUMBER 6*

## MILITARY SURGERY

THREE YEAR CUMULATIVE INDEX

*1 h 19 20 a d 21*

(1939 1940 d 1941)

PHILADELPHI D LONDON

W B SAUNDERS COMPANY

---



PUB ISHED NTHL ( X M P COMP Y ST ASHIN TO

SQ PHILAD LPHIA

MAD IN A.

# CONTRIBUTORS TO THIS NUMBER

---

JOHN C ADAMS M D C pt M l cal C p U ted St t N vy B f M d d S g y N y D p tm t W h gt D C

CARLTON L ANDRUS M D F ACS C mm l Med cal C p U t d St t N y B f M d d S g y N vy D p tm t W h gt D C

CHARLES F BEHRENS M D C mm d M d cal C p U t d St t N y U S N l H pt l W h gt D C

CHARLES Y BIDGOOD M D F ACS L t t C m d Med cal C p U t d S t N l R N l M d cal C t W h gt D C

ALFRED BLALOCK M D F ACS M be f C mm tt T f d Cha f S b m t Sh k N t l R h C l l f f S g y J h H pk U ty S g Ch f J h H pk H p t l

VIRGIL H CARSON M D F ACS C pt M l l C p U t d St t N y E t Offi U S N l H pt l B klyn N Y

FREDRIC I CONKLIN M D F ACS C pt M d cal C p U t d St t N y U S N l H pt l Sa D g C l f

GOUVERNEUR V EMERSON M D F ACS C l l M d l C p U t d St t Army Ch f f S g l S L tt G l H pt l S l sc C l f

CHARLES F FLOWER M D L t t C mm d M d cal C ps U t d St t N y

DANIEL FRANKLIN M D F ACS l t t C l l M d cal C p U t d St t W l l d C l H pt l W h gt D C

NORMAN E FREEMAN M D F ACS M j M l cal I serv C p U t d S t A M mb f S l mm tt Sh k N t l R h C l A t t P f f R se h S g y H D p tm t f S g School f Med U ty f I yl

JAMES P FULTON M D F ACS I t t C m d M d cal C p U d St t N y U S S R I f U t d Stat H t

FRANCIS C GRANT M D F ACS I f f N k S l ool f M l U f l l

FREDERICK R HOOK M D F ACS Capt Med cal C p U t l t N Cl f f S g l U S N l H pt l W h gt D C

ROBERT H IVY M D F ACS C l l M l cal I serv C p U ted t A M l f C t e S g y N t f l se h C cal l f so f M ll f ial k ry Sch l f Med U t f P yl a

## CONTRIBUTORS TO THIS NUMBER

NORMAN T KIRK M D F A C S C l l M d cal C ps U ed S A my Ch f f S g cal Serv W l Reed Ge ral Hosp t l W h ingt D C

RICHARD H LANING M D F A C S Capta Med cal C rps U t d St t N vy M d cal D ct N f lk N l H p tal P rt m h V

JOHN S LOCKWOOD M D Sc D (Med ) M mbe f C mm t e Ch m th pe d Oth Ag t d S bc mm tt g cal I fectio N t l R se h C l A socia S g ry School f Medic U rs y f P l a ia D ect f T m Clin H s pt l f th U rs y f P l

JAMES C MAGEE M D F A C S M j Ge l U ted St tes A my Th Surgeo Ge l

I S RAVDIN M D F A C S L t C l l Med cal Reserv Corp U ted S t Army M mbe f N l C mm tee (S g cal Sect ) Med cal I pa ed es H so P f so f S g ry d Direct f th H rr so D partm t f S g cal R sc h School f Med U y f P yl a ia

LOUIS H RODDIS M D F A C P Cap Med cal C p U ed St N vy Ed t U ted S N l M d cal B ll t W hingt D C

WILLIAM D SMALL M D F A C S C mm d Med cal Corps U ed St t N vy

ROY A STOUT D D S L t C l l De t l C rp U d St t Army W lt Reed Ge ral Hosp l W hingt D C

FREDERIC H THORNE M D F A C S L C l l Med cal C p U t d S t A my Ch f f Ey La N se and Th oat Serv ce St t H p l F rt Sam H t T

# CONTENTS

SYMPOSIUM ON MILITARY SURGERY

CONTENTS

# THE SURGICAL CLINICS OF NORTH AMERICA

Volume 21 | December 1941 | Number 6


## SYMPOSIUM ON MILITARY SURGERY

### FOREWORD

With the activities of the military establishment increased as the result of the present training program adequate medical care of our Army and Navy personnel becomes a problem of major importance The Army and Navy medical establishments are expanding rapidly to meet the situation

Inasmuch as time for special training in the medical and surgical specialties is not available the newly commissioned medical officer must depend upon his background of experience in civil life supplemented whenever practicable by brief orientation courses to assist him in applying that knowledge to the problems encountered in military service

I consider the articles contained in this issue of the Surgical Clinics of North America as most opportune *Written by outstanding authorities cognizant of the necessary adaptations of civil methods to military practice they will provide a valuable fund of professional information for surgeons entering or thinking of entering the Services They will likewise assist teaching institutions which in last analysis must give the fundamental training necessary for the practice of military medicine*

From the viewpoint of the medical services of the Army and Navy it is gratifying to note the close cooperation between military and civilian physicians in the preparation of this volume

*Major General United States Army*
*The Surgeon General*

CONTENTS

S rgical Cl ni f N th A
D emb 1941

# NEW SURGICAL METHODS OF MILITARY SIGNIFICANCE

I S RAVDIN M D F A C S

L E C EL M CAL RESER E CO S UNITED ST A MEM
N C TTE (SUR ICAL SECTIO ) MED CAL P D-
ESS H I P ES S R ERY D DIR CTO TH H I N
D AR T S RESEA CH SCH M CIN U IVERS Y
P L A IA

CERTAIN developments in the field of preoperative and post operative care will without doubt be of great value to our armed forces should they become involved in military actions resulting in casualties In addition to these developments are ome of a technical nature a clearer understanding of which will also lead to a substantial reduction in the morbidity and mortality of many injuries and a shorter period of conval escence

Many of these extensions of our knowledge will be compre hensively dealt with in the papers by various authors which are to follow It is my function merely to pass in review a number of these developments and to point out briefly their importance at this critical time It is just as or even more important that the men entrusted with the surgical care of our soldiers and sailors be familiar with the significance of these new methods as it is that civilian surgeons be familiar with them The successful military surgeon of the future will need to have the training and background of the civilian sur geon and in addition must obtain special knowledge of the problems of military action and movement The mobile war fare of the present conflict has created and will continue to create new problems for the Medical Corp of the Army and Navy Semi fixed ho pitals can no lon er be kept directly be hind a front line for as yet little trench warfare has been seen

thetics during gunfire would preclude the use of certain of our more commonly used anesthetics Furthermore the apparatus necessary for the administration of many anesthetics now com monly used in civilian ho pitals may prevent their use at sea or on land except at more or less fixed stations Will it not be comforting to know that the danger of chloroform injury to the liver can be greatly reduced by the provision of a suf ficient amount of an adequate protein in the rations of our men? The protein need not necessarily be given as meat but can be given as some form of casein soybean or protein digest

An adequate protein intake is of importance not only in protecting certain viscera from the degeneration or necrosis which may follow exposure to a variety of harmful agents (chloroform carbon tetrachloride arsenic and the sulfo namides) but is of great importance also in facilitating *repair of injured tissues* Tissue repair requires protein components and yet the soft diets given many patients during periods of convalescence are totally inadequate for maximal or even nor mal repair One of my associates Dr J E Rhoads has re cently demonstrated the importance of preventing hypopro teinemia if normal bone repair is to take place The rapidity with which extensive wounds and decubitus ulcers undergo improvement when the protein intake is adequate is sufficient evidence to warrant a wider knowledge of this factor in the care of the convalescing surgical patient

**Vitamins**—Not only is protein of value in maximal wound repair but an adequate intake of vitamin C also is required A small amount of this vitamin in the body will result in the faulty laying down of collagen Lanman and Ingalls and Lund and Crandon have opened a new chapter in surgical manage ment by their excellent studies Other vitamins also are of im portance such as various components of the B complex K A and D

**Fluids**—Normally the plasma protein of the blood is the major factor in keeping fluid in the blood vessels A prolonged reduction of protein in the diet leads to hypoproteinemia which in turn predi poses to edema Such a circumstance leads

in the present conflict With the modern use of bombin planes ships are being exposed to a type of prolonged attack that was not possible when the battle was limited to fightin between ship These and many other factors present new problems which must be met by changes in our methods of organization

## NUTRITIONAL FACTORS IN THE CARE OF THE INJURED

It has been known for a long time that the caloric require ments of men actively engaged in military action exceed tho e of men leading more sedentary lives It has not been known however hov important diet may be in the care of the injured During the first Great War and for some years thereafter surgeons paid little attention to the diet of their patients Many of the chronic di abilities which resulted after injury were due to our lack of knowled e both of the importance of nutrition prior to injury and its additional importa ce during convalescence Surgeons were not alone in their ignorance of dietary requ rements for medical men generally knew little about this important branch of science The v tam ns a we know them today were unknown the ntermediary metab olism of many of our food tuffs was not yet discovered

Surgeon now know that the loss of weight of a patient dur ing hospitalization is a concrete expression f the extent to wh ch they ha e failed to meet the energy equ rements of the patient durin treatment It became known du ng the war of 1914–1918 that patients with tho ac c empyema mpr ved more rapidly if they were kept on n intake of 4000 calo es or even more Dubo demonstrated that pat ents w th extens v suppuration could not be kept in a po iti e n t ogen bala c e en though the intake of protein was several times that normally required to keep them in positi balance But such data did not go far enough nor was the inform tion or ts im portance sufficiently stre sed to be of really s nif cant value in the care of our patients

**Adequate Proteins**—It m y become n e ary to use chlorof rm as the major anesthetic boa d our sh p at ea for the risk nvolved in u ing inflammable or e pl si e anes

thetics during gunfire would preclude the use of certain of our more commonly used anesthetics Furthermore the apparatus necessary for the administration of many anesthetics now commonly used in civilian hospitals may prevent their use at sea or on land except at more or less fixed stations Will it not be comforting to know that the danger of chloroform injury to the liver can be greatly reduced by the provision of a sufficient amount of an adequate protein in the rations of our men? The protein need not necessarily be given as meat but can be given as some form of casein soybean or protein digest

An adequate protein intake is of importance not only in protecting certain viscera from the degeneration or necrosis which may follow exposure to a variety of harmful agents (chloroform carbon tetrachloride arsenic and the sulfonamides) but is of great importance also in facilitating *repair of injured tissues* Tissue repair requires protein components and yet the soft diets given many patients during period of convalescence are totally inadequate for maximal or even normal repair One of my associates Dr J E Rhoad has recently demonstrated the importance of preventing hypoproteinemia if normal bone repair is to take place The rapidity with which extensive wounds and decubitus ulcers undergo improvement when the protein intake is adequate is sufficient evidence to warrant a wider knowledge of this factor in the care of the convalescing surgical patient

**Vitamins**—Not only is protein of value in maximal wound repair but an adequate intake of vitamin C also i required A small amount of this vitamin in the body will result in the faulty laying down of collagen Lanman and Ingalls and Lund and Crandon have opened a new chapter in surgical management by their excellent studies Other vitamins also are of importance such as various components of the B complex K A and D

**Fluids**—Normally the plasma protein of the blood is the major factor in keeping fluids in the blood vessels A prolonged reduction of protein in the diet leads to hypoproteinemia which in turn predisposes to edema Such a circumstance leads

not only to faulty wound healing but to an increase in the incidence of postoperative pulmonary complications wound in fections and decubitus ulcers Eventually it may be demon strated that reduction of protein in the diet plays an important part in conditioning the onset of the syndrome of shock fol lowing trauma of a degree which under normal conditions of the plasma protein would not be sufficient to initiate shock

The extensive development of *blood* and *plasma* or *serum banks* and the gradual adoption of the use of lyophile plasma has had a profound effect on surgical care It i now almost as easy to administer plasma or serum as it is to administer sodium chloride intravenou ly The advantage of these sub stances is that they will remain in the circulation while sodium chloride tend to leave the vessels rapidly Even when consid erable hemorrhage has occurred plasma will often be just as useful as blood and plasma has the additional advanta e that agglutination tests are not equ red prior to its introduction

## SHOCK

Dr Blalock who in th s Symposium is cont butin the clinic on shock has made many of the outstandin contribu tions to our knowledge on this subject He would I am sure be one of the f rst to admit that much re ains to be known about it Blalock was the first to demonstrate the extensi e local loss of fluid follo in serious traum and he ha epeat edly emphasized the fact that the repl cement of this fluid by substances hich are likely to remai in the blood e sel the most impo tant single factor n the treatment of sho k

The fall in blood pressu e which many su ge ns now look for as an ind cation of hock frequently takes plac some hours after the in tiation of the process wh ch lead to the shocklike state It would be of untold benefit we e we able to diagnose the earliest s ns of the progres e d tu bances which lead to an irrevers ble state of hock Hea y respons bility rests on those now carryin on est gations in thi f eld Until they have prov ded the necessary i formati n we must continue to attempt to mai tain a normal blood olume

by the use of serum or plasma It is far better to give too much serum or plasma than too little

## BURNS

Because of the extensive burns which may result during and following air raids it is important that all useful knowledge on burns be made available It is generally agreed that a serious reduction in blood volume follows extensive burning of cutaneous surfaces The *blood volume* must be supported by serum or plasma transfusions for the process here is not unlike that seen in shock resulting from other forms of trauma

Denuded cutaneous surfaces are highly susceptible to infection Much of the infection which has been observed in burns has come about as the result of improper care It is even more important to dress wounds due to burns with rigid regard to *asepsis* than to observe these principles in dressing ordinary postoperative wounds Yet the care of wounds due to burns is often relegated to inexperienced individuals Fortunately it is now possible to limit greatly the extent incidence and degree of infection by adequate wound treatment and the local use of sulfanilamide If death due to a reduction in blood volume can be prevented if infection can be aborted then skin grafting can be carried out a short time after injury and what in the past has led too frequently to a protracted convalescence and extensive disfigurement in the future may lead to speedy recovery and a satisfactory cosmetic and functional result In a clinic in this Symposium Dr Ivy will illustrate the many ways in which the plastic surgeon can be of great help in the management of these cases

## ANTISEPTIC AGENTS

During the war of 1914–1918 we were initiated to a host of new antiseptic agents most of which except *Dakin s solution* have now been long forgotten Dakin s solution remains as a useful agent because of its unique ability to cause lysis of necrotic tissue The aim of surgeons in the present conflict must be to prevent invasive infection in contaminated wounds The recent development of *sulfonamide therapy* lead us to believe that

the intelligent use of sulfanilamide sulfathiazole or sulfadiazine orally locally or parenterally will result in a substantial reduction in the number of serious infection which in past wars have been so common and have cost so many lives Dr Lockwood and Dr Gibbon will di cuss the mana ement of many specific lesions

## COMPOUND FRACTURE

When Orr first suggested the *closed plaster method* of treating compound fractures the method was not widely adopted but when Trueta in Spain utilized thi procedure durin the Loyalist Nationalist war in that country it was widely heralded and has now been exten ively employed abroad and in this country The method undoubtedly lead to a marked reduction in the incidence of secondary infection to greater comfort to the patient because it doe away with frequent dressings and without doubt in many instances to a higher incidence of bony union with less di ab l ty and a shorter convalescence

The data of the war of 1914–1918 re ealed that there was a progressive increase in the number of wound containin hemolytic streptococci from the time the men ere first treated in a ca ualty clear n station until they were ad nitted to a base hospital Stokes and hi colleague found that 15 p r cent of the wound were already infected with the hemolytic streptococci at casualty clearing station and Flem g and Porteu reported that 90 per cent of the wounds were o i fected hen examined at the ba e Such add t onal infect n s i large part due to the contamination which took place durin rep ated dre sings appl ed under improper conditions The s ffer di ability and loss of life which took place as a esult of thi contaminat on can now in large part b prevented Every u ical officer should recei e train ng n the ind catio s f r the u e f the clo ed plaster method the method of it applicati and the part wh ch chemotherapy may play s an adjunct

The e improvements n su gery are but a few of the ad ances recently de eloped that a e of milita y si ificance

They serve to illustrate the direction of surgical thought and the importance of attention to the many details outside of surgical maneuvers which may influence the final results of injuries It is to be hoped that these and other additions to our knowledge may lead to a very marked reduction in the morbidity and mortality of the injuries which may occur to civilians and to our military forces in the event of war

the intelli_gent use of sulfanilamide sulfathiazole or sulfadia zine orally locally or parenterally will result in a substantial reduction in the number of serious infections which in past wars have been o common and have co t so many lives Dr Lockwood and Dr Gibbon will discuss the mana emer t of many specific lesions

## COMPOUND FRACTURE

When Orr first suggested the *closed plaster metl od* of treat ing compound fractures the method was not widelv adopted but wh n Trueta in Spain utilized thi procedure during the Loyalist Nationalist wa n that country it was widely her alded and has now been extensively employed abroad and in this country The method undoubtedly leads to a marked re duction in the inc dence of secondary infection to greater comfo t to the patient because t does away with frequent dressings and without doubt in many instances to a h her incidence of bony union with le s d abil ty and a shorter convalescence

The dat of the war of 1914–1918 re ealed that there was a progres ive increase in the numbe of unds containin hemolytic treptococci from the t ne the men wer first t eated in a casualty clear n station until they were admitted to a ba e ho pital Stokes and his collea_u s f u d that 15 pe cent of the wounds were already nfect d with the h m lytic strep tococci at casualty cleari g stat ns nd Fl m n a d Po teus reportd that 90 per cent of the wounds we e so infected wh n examired at the base Such add t onal nfection was in la g part due to the contam nation wh ch took plac dur n_g repeated dress ngs applied under improper condit ons Th ufte in di ability and loss of life which took place a a r sult of thi con taminat on can now n large part be p e ent d E y urgical officer should receive tra ning n th ndi ations for the u e of the closed pla ter method the meth ds of ts appl catio and the part wh ch chemotherapy may play as an adj t

Th se impro ements in sur ery are but a few of the ad ances recently de eloped that are of m l tary s n f cance

# ORGANIZATION OF THE NAVY MEDICAL DEPARTMENT

LOUIS H RODDIS M D F A C P

C PT N MED C C PS U ED S ES N Y E IT U ED S N AL MED B IN W HING ON D C

---

THE principal divisions of the Medical Department of the Navy are

Medical Corps
De tal Corps
Pharmacists
Nurse Corp
H p tal Corps

The first of these the *Medical Corps* is made up of physicians who are graduates of recognized medical schools These men are selected after careful physical and professional examinations For appointment to the Medical Corps of the regular Navy they must also be citizens of the United States and less than thirty two years of age The number of medical officers in the Navy as prescribed by law is 6½ per thousand of the total authorized strength of the Navy and Marine Corps thus if the total strength of the Navy and Marine Corps were 100 000 650 medical officers would be required

The *Dental Corps* is made up of dentists who must be under thirty two years of age graduates of recognized dental schools and who also must pass a rigid physical and professional examination The proportion of dental officers is one for every 500 of the authorized stren th of the Navy

The *Pharmacists* are not as definitely allotted by law At present there are about 200 for the whole Navy In addition to the

Th p t ns t d b th pri t f th t l re t t be n tru d ff l fl t g th f th Dep rtm t th N l Se t la ge

performed under authority of the Secretary of the Navy The orders of these bureaus are considered as emanating from him and having the full force and effect of his authority

**Duties and Responsibilities**—In order to give an idea of the work of the Bureau of Medicine and Surgery it would perhaps be best to quote directly from the U S Navy Regulations the duties and responsibilities attached to this Bureau

### SECTION 1—DUTIES OF THE BUREAU OF MEDICINE AND SURGERY

457

1 The Bureau of Medicine and Surgery under the direction of the Secretary of the Navy is charged with and responsible for the maintenance of the health of the Navy for the care of the sick and injured for the custody and preservation of the records accounts and properties under its cognizance and pertaining to its duties and for the professional education and training of officers nurses and enlisted men of the Medical Department of the Navy

2 It is charged with the upkeep and operation of all naval hospitals medical supply depots medical laboratories the Naval Medical School and of all technical schools established for the education and training of members of the Medical Corps Dental Corps Nurse Corps and Hospital Corps and with their repairs except as excluded article 484

458

1 The Bureau of Medicine and Surgery shall provide for inspection of the sanitary condition of the Navy shall recommend with respect to all questions connected with hygiene and sanitation affecting the service and to that end shall have opportunity for necessary inspection It shall advise with other bureaus and offices in reference to the sanitary features of ships under construction and in commission regarding berthing ventilation and location of quarters for the care and treatment of the sick and injured of the provisions for the care of wounded in battle and in the case of shore stations with regard to health conditions depending on location the hygienic construction and care of public buildings especially of barracks and other habitations such as camps It shall also advise concerning matters pertaining to clothing and food to water supplies used for drinking cooking and bathing purposes and to drainage and disposal of wastes so

practice of pharmacy they carry on the detail of finance and property accounting

The *Nurse Corps* is made up of women nurses who must be graduates of recognized nursing schools and not more than twenty-eight years of age at entrance into the Navy The proportion of nurses is three per thousand of the authorized strength of the Navy

The *Hospital Corps* is made up of enlisted men and consists of 3½ per cent of the total authorized enlisted strength of the Navy and Marine Corps The men of this corps do much of the nursing work first aid and practical pharmaceutical work For various reasons women cannot be employed at these tasks on combat ships or in the field

The task of the Medical Department of the Navy is a very large one It includes the physical selection of all personnel the maintenance of health and the care of the sick and injured as well as the removal by retirement of those who have become permanently disabled or are unfit for further active service It must be remembered too that this work has to be carried out both afloat and ashore and in many parts of the world under varying climatic conditions and in widely diverse surroundings Also the civil population of some of our island possessions beyond the seas notably Samoa and Guam is entirely dependent upon the Medical Department of the Navy for all medical care

The administrative head of the Medical Department of the Navy is the *Surgeon General* who is the chief of the Bureau of Medicine and Surgery He is appointed by the President for a period of four years

## THE BUREAU OF MEDICINE AND SURGERY

The Bureau of Medicine and Surgery is the central administrative organization of the Medical Department It is one of five bureaus established in the Navy Department by the Act of Congress of August 31 1842 This Act provided that the several bureaus should retain the charge of records and accounts pertaining to their respective duties such duties to be

performed under authority of the Secretary of the Navy The orders of these bureaus are considered as emanating from him and having the full force and effect of his authority

**Duties and Responsibilities** —In order to give an idea of the work of the Bureau of Medicine and Surgery it would perhaps be best to quote directly from the U S Navy Regulations the duties and responsibilities attached to this Bureau

SECTION 1—DUTIES OF THE BUREAU OF MEDICINE AND SURGERY

457

1 The Bu eau of Medicine and Surgery under the direction of the Se etary of the Navy s charged with and responsible for the maintenance of the health of the Navy for the care of the ck a d injured for the custody and p eservat on of the rec rds cc unts and properties u der its cognizance and per ta ning to ts duties and for the professional educat on and trai g of offce s nu ses a d enlisted men of the Med cal Department f the Navy

2 It charged with the upkeep and operation of all naval h p tals medical supply depot med cal laboratories the Naval Medical School a d of all technical school established for the educati n r tra nin f membe s of the Medical Corp Dental Corps Nurse Corps and Hospital Corps and with thei repai s e cept as e cluded a ticle 484

458

1 Th Bureau of Medic ne and Surgery shall prov de for in pection of the san tary cond tion of the Navy shall recommend with respect to all quest ons connected with hygiene and sanita t on affecti g the serv ce and to this e d shall have opportunity f necessa y in pection it shall adv e w th other bureaus and office in refere ce to the san ta y fe tures of sh ps under con *structio* and i comm ss on regarding berthing ventilation and location of quarters for the care and treatment of the *s ck and* i jured of the pr visions for the care of ou ded in battle and in the case f hore stations v th reg rd to health cond tions depend ng n locat on the hyg enic constru t on and ca e *of pub*l c bu ld ngs e pecially of ba racks and other habitations such as *camps It shall* also ad i e c ncern ng matters pe ta n ng to cl th ng and f od to water suppl es used for dr nking cooki g and bath ng purposes and to d ainage and disposal of wastes so

f r a these affect the health of the Navy It shall safeguard the personnel by the employme t of the best method of hyg ene and sanitat o both afloat a d asho th view t mainta n n the h hest po s bl pe t ge f the per el ready for serv c at all times a d h ll d pt for u-e all such d ices o p oced as may be dev l ped in the sciences of med e d gery w ll in any y tend t an inc eas in m l tary efficiency

2 It h ll be the duty of the B reau f Med ci e d S g y t p ov de f the phy cal e aminat o of fi c rs nurses d e list d me with a v w to th select or rete t on f tho o ly whose phys l c nd t is uch as to ma ta impro e the m l tary ffic ency f the r ce f admitted o reta ned th n a d t shall p s upo the compet y f m p ofes- al st dp int of all m f the Ho p tal Corp f r e list ment e llm t and p motion by means f exam ations o ducted unde ts superv o o by uch forms as it may p esc be

3 The B ea of Med c a d S g ry h ll recommend to th Bu e u f N t th mpleme t f Med cal Depa t m nt pe sonn l for h p t l a d h pital sh ps a d h ll c m me d d h e i f rmat n as to the ass gnme t a d dut es f medical off e dent l fn e s d ho p t l corpsmen It h ll be ch ged w th the admi istrat n f the N s C rp d shall have po e t ppo t d rem ll s s subject to the p p o l f the Secretary of the N y

4 It sh ll requ re f d ha e co t l of th p p t o nspect o r pt n t ra ca custody tran f d issue of ll s ppl s f every kind used in the Med cal D partme t fo its own p rposes and hall ha ch ge f th c il f ce em ployed at n l hosp tals m d cal pply d p ts medi al labo t the N l Med cal School d t all techn cal schools f r the ed cat on t a f M d c l D p tme t perso nel

5 It h ll pp o the des gn f h p tal h ps insof as re- l tes t the ffi e y f the ca f the k and wou ded and sh ll p o d f the o g at o d dn t at f the Med al Dep rtm t f su h s els

6 The a an em nts fo care t an portat o d b l of the d d sh ll be unde th j sd ct o a d t l f th B eau of Med c n a d Su y e ept as otherwise p o ded in a t cl 1841

**Organization**—To carry out the tasks laid down by the Regulat ons which have been quoted above equires a com plete and thorou h organ ation of both the Bureau and of the

entire Medical Department The main features of this organization will now be briefly described First the Bureau itself consists of the office of the Surgeon General and Assistant Chief of Bureau Under these men as directing head are the following divisions

| | |
|---|---|
| Hospitals and Inspections | Finance |
| Planning | Preventive Medicine |
| Chief Clerk | Publications |
| Dental Corps | Aviation Medicine |
| Medical Corps | Physical Qualifications and Records |
| Hospital Corps | |
| Nurse Corps | |

While the titles of these divisions are almost self explanatory as to their duties a few words may be added in regard to the tasks of some of them For example the *Division of Personnel* is responsible for the admission of personnel to the service their transfer and movement from one station to another their examinations for promotion their leave and other similar matters The *Division of Finance* has to do with the preparation of the budgets and the approval of requisitions required to purchase supplies and equipment for the Medical Department throughout the world A division of great importance is that of *Physical Qualifications and Records* Records are to be found here of personnel extending back to the War of 1812 Another division which is of great value is that of *Preventive Medicine* It is said that in civilian life the specialty of the general practitioner is obstetrics It may almost be said that the specialty of the Naval surgeon is preventive medicine

In the Bureau of Medicine and Surgery there is another important office—that of the *Chief Clerk* The Chief Clerk is a civilian who has charge of and is responsible for civilian personnel He is the assistant to the Surgeon General in regard to the entire administrative machinery of the Bureau

Another division of considerable interest is that of *Publications* Various technical books and manuals such as the Handbook of the Hospital Corps and also the Reports of the Surgeon General of the Navy are prepared and published for the

u e of the Medical Department In addition the Navy pub li hes a medical journal de oted to naval and military medicine This journal known as the *United States Naval Medical Bulletin* was founded in *1907* It was for a lon time the only journal devoted to naval medicine published in the Americas

Another important unit thou_h not directly a part of the Bureau deal with important Bureau policies Thi i the *Advisory Board* organized for the purpo e of assistin the Surgeon General particularly with the work of postgraduate instruction It also is concerned with other matters especially the preparation of scientific and professional books and periodicals needed by the Medical Department This board selects officers for postgraduate instruction in civilian medical schools and for pecial work in the Naval Medical School

## FACILITIES FOR THE TRAINING OF MEDICAL PERSONNEL

### NAVAL MEDICAL SCHOOL POSTGRADUATE INSTRUCTION

The Naval Medical School Washington D C is a school of postgraduate instruction that specializes in the subjects of naval medicine It is the only school giving instruction in thi specialty in the United States and i the lar est and mo t important one in the Western Hemisphere Furthermore its library contains the largest collection of books periodical pamphlets pictures and other data on nautical medicine to be found in the New World The Na al Medical School forms a part with the Naval Ho pital and the Dental School of a great medical group known as the Naval Medical Center Wa hington D C One other important function of the Naval Medical School should be noted The school serves as a consulting center for the enti e Naval Service Med cal officers in all parts of the world end patholo ic pe imens here for dia nostic study and confirmat on

### SCHOOLS FOR HOSPITAL CORPS IEN

*Other important* instruction carried out under *the Bureau* of Med cine and Surgery includes the training of hosp tal corpsmen There are tv o training school regularly ma ntained

—one at Norfolk Virginia and the other at San Diego California In these schools instruction is given in first aid elementary pharmacy and chemistry elementary hygiene and sanitation nursing and similar subjects as well as military drill Special instruction also is given in various technical branches to train men as technicians in the fields of $x$ ray laboratory pharmacy dental prosthesis and related fields

## NAVAL HOSPITALS AND OTHER FACILITIES FOR TREATMENT AND EXAMINATION

The Navy maintains a number of large and important Naval hospitals within the continental limits of the United States and three more beyond the seas The latter are at Canacao Philippine Island Pearl Harbor Territory of Hawaii and Guam Naval hospitals like large general hospitals in civil life contain patients with a great variety of pathological conditions requiring every sort of treatment These hospitals are equipped with every facility to be found in the largest and finest civilian hospitals Some idea of the volume of work which passes through them may be obtained from the data of a recent calendar year when more than 30 000 surgical operations were performed while there also took place many minor procedures such as cystoscopies bronchoscopies and similar examinations

The largest single group of diseases cared for in our hospitals is the group of communicable diseases transmitted by oral and nasal discharges This group furnishes almost one third of all admissions to the sick list Wound and injuries attributable to the many hazards peculiar to naval and military life are another important cau e of morbidity These injuries provide about 10 per cent of all original admissions to the sick list Many of them occur in the operation of submarines the handling of guns and ammunition aboard hip falls through hatches and from masts falls overboard and similar accidents

The Naval ho pitals are organized with the usual clinical and professional services Each hospital has surgical medical eye ear no e and throat and urological ervices as well as facilities for roentgenology and physiotherapy and laboratory

use of the Medical Department In addition the Navy pub lishes a medical journal devoted to naval and military medicine This journal known as the *United States Naval Medical Bulletin* was founded in 1907 It was for a long time the only journal devoted to naval medicine published in the America

Another important unit though not directly a part of the Bureau deal with important Bureau polic es This i the *Advisory Board* organized for the purpose of assisting the Surgeon General particularly with the work of postgraduate instruction It also is concerned with other matters especially the preparation of scient fic and professional books and periodicals needed by the Medical Department This board selects offi cers for postgraduate instruction in civilian medical schools and for special work in the Naval Medical School

## FACILITIES FOR THE TRAINING OF MEDICAL PERSONNEL

### N VAL MED CAL SCHOOL POSTGRADUATE INSTRUCTION

The Naval Medical School Washin ton D C is a school of postgraduate instruction that pecializes in the subjects of naval medic ne It is the only school giving instruction in thi specialty in the United States and is the largest and most important one in the Western Hem sphere Furthermore its library contains the largest collection of books periodicals pamphlets p ctures and other data on nautical medicine to be found in the New World The Naval Medical School forms a part with the Naval Hospital and the Dental School of a great med cal group known as the Naval Medical Center Washington D C One other important function of the Naval Medical School should be noted The school serves as a con sulting center for the entire Naval Service Medical officers in all parts of the world send pathologic specimens here fo diag nostic study and confirmation

### SCHOOLS O HOSPITAL CORPS MEN

Other important instruct on carried out under the Bureau of Medicine and Surgery includes the tra ning of hospital corpsmen There are two trainin schools regularly ma ntained

—one at Norfolk Virginia and the other at San Diego California In these schools instruction is given in first aid elementary pharmacy and chemistry elementary hygiene and sanitation nursing and similar subjects as well as military drill Special instruction also is given in various technical branches to train men as technicians in the fields of $x$ ray laboratory pharmacy dental prosthesis and related fields

## NAVAL HOSPITALS AND OTHER FACILITIES FOR TREATMENT AND EXAMINATION

The Navy maintains a number of large and important Naval hospitals within the continental limits of the United States and three more beyond the seas The latter are at Canacao Philippine Islands Pearl Harbor Territory of Hawaii and Guam Naval hospitals like large general hospitals in civil life contain patients with a great variety of pathological conditions requiring every sort of treatment The e hospitals are equipped with every facility to be found in the largest and finest civilian hospitals Some idea of the volume of work which passes through them may be obtained from the data of a recent calendar year when more than 30 000 surgical operations were performed while there also took place many minor procedures such as cystoscopies bronchoscopies and similar examinations

The largest single group of diseases cared for in our hospitals is the group of communicable diseases transmitted by oral and nasal discharges This group furnishes almost one third of all admissions to the sick list Wounds and injuries attributable to the many hazards peculiar to naval and military life are another important cause of morbidity These injuries provide about 10 per cent of all original admissions to the sick list Many of them occur in the operation of submarines the handling of guns and ammunition aboard ship fall through hatches and from masts falls overboard and similar accidents

The Naval ho pitals are organized with the usual clinical and professional services Each hospital has surgical medical eye ear no e and throat and urological ervices as well as facilities for roentgenology and physiotherapy and laboratory

u e of the Medical Department In addition the Navy publi he a medical journal devoted to naval and military medicine This journal known as th *United States Naval Medical Bul l tin* was founded in 1907 It wa for a long time the only journal devoted to naval medicine publi hed in the America

Another important unit though not directly a part of the Bureau deal with important Bureau policies Thi i the *Ad visory Board* organized for the purpo e of a si ting the Sur geon General particularly with the work of po tgraduate in truction It al o is concerned with other matter e pecially the preparation of cientific and professional books and period ical needed by the Medical Department Thi board elects officers for po tgraduate in truction in civilian medical chool and for pecial work in the Naval Medical School

## FACILITIES FOR THE TRAINING OF MEDICAL PERSONNEL

### NAVAL MEDICAL SCHOOL POSTG ADUATE INSTRUCTION

The Naval Medical S hool Wa hington D C is a chool of po tgraduate in truction that pecializes in the subjects of naval medicine It i the only chool gi ing instruction in thi pecialty in the United State and i the larg t and most important one in the We tern Hemi pher Furthermore it library contain the large t collection of books period cal pamphlets picture and other data on nautical medicine to b found in the New World The Naval Medical School form a part with the Naval Ho pital and the D ntal School of a great medical group known a the Naval Medical Center Wa hington D C One other important function of the Naval Medical Sch ol hould be noted The chool erves a a con ulting center for the entire Naval S rvice Medical officers in all part of the world en l patholo ic pecimen here for diag no tic tudy and confirmation

### SCHOOLS FO HOSPITAL CO PS EN

Other important in truction carr ed out under the Bureau of Medi ine and Surgery include the training of ho pital co ps men There are two training ch ol regularly maintained

—one at Norfolk Virginia and the other at San Diego California In these schools instruction is given in first aid elementary pharmacy and chemistry elementary hygiene and sanitation nursing and similar subjects as well as military drill Special instruction also is given in various technical branches to train men as technicians in the fields of $x$ ray laboratory pharmacy dental prosthesis and related fields

## NAVAL HOSPITALS AND OTHER FACILITIES FOR TREATMENT AND EXAMINATION

The Navy maintains a number of large and important Naval hospitals within the continental limits of the United States and three more beyond the seas The latter are at Canacao Philippine Islands Pearl Harbor Territory of Hawaii and Guam Naval hospitals like large general hospitals in civil life contain patients with a great variety of pathological conditions requiring every sort of treatment The e hospitals are equipped with every facility to be found in the largest and finest civilian hospitals Some idea of the volume of work which passes through them may be obtained from the data of a recent calendar year when more than 30 000 surgical operations were performed while there also took place many minor procedures such as cystoscopies bronchoscopies and similar examinations

The largest single group of diseases cared for in our hospitals is the group of communicable diseases transmitted by oral and nasal discharges This group furnishes almost one third of all admissions to the sick list Wounds and injuries attributable to the many hazards peculiar to naval and military life are another important cau e of morbidity These injurie provide about 10 per cent of all original admissions to the ick list Many of them occur in the operation of submarines the handling of guns and ammunition aboard ship falls through hatches and from masts falls overboard and similar accidents

The Naval ho pitals are organized with the usual clinical and professional services Each hospital has surgical *medical* eye ear no e and throat and urological ervices as well as facilities for roentgenology and physiotherapy and laboratory

neuropsychiatric and dental work To most of the hospital an out patient clinic is attached In each hospital are important administrative groups These are a personnel and record office a property and accounting office a commissary a disbursing office a maintenance department There al o i a group in charge of morale and tra nin activities in connection with the instruction of hospital corpsmen on duty at the hospitals The administrative head of our ho pital i the medical officer in command whose chief assistant is the executive officer An officer of the day who is the direct representative of the Commanding Officer i on duty at all times in our ho pital

### Hospital Ships

An interesting activity of the Medical Department i that of the hospital ships These are in effect floating hospitals designed to accompany the Fleet and to furni h hosp talization in any part of the world where the Fleet may go The e ships have to be moderately large commodious comfortable and fairly fast Their medical facilities include practically every service found in a ho pital ashore

### Mo ile Ba e Hospitals

Mobile base hospitals are hosp tal which can be assembled and their personnel and material mo ed to distant points whe e they furnish ho pitalization pa t cula ly to adv nced bases and Marine exped tionary forces

### Medical Dep rtment of Ships nd Shor St tions

Th number of medical departments of ships and hore station runs into hundred Every sh p a d sh e tat n except the smallest i equipped with a medical depa tment which i cludes a pharmacy a medical store oom a exa in g roon a ward and in most instances a small i lat on un t Wh le the ho pital supply definitive treatment these medical departments of ships and sho t statio s everywhere supply the temporary medical servi e to the officers and men of th sh ps or stations They handle all acute conditions all immediate

emergencies and provide the preventive medical service necessary to maintain the health of the command A medical officer heads all these activities He is often like the country practitioner in a small town with many of the same professional problems and in addition those of a military organization

### Dispensaries and Navy Yards

Dispensaries and navy yards have an important task in connection not only with the care of Naval personnel but also with the provision of emergency treatment for civil employees The medical officers of dispensaries of the yards have also the problems of industrial medicine to deal with in their regular work

### Recruiting Stations and Training Stations

Medical officers of course are necessary at recruiting stations to carry on physical examinations of recruits The physical selection of personnel is one of the most important tasks of the Medical Department It requires not only the professional knowledge necessary to make physical examinations but an intimate acquaintance with the requirements of the Naval Service in order to select properly the best men In the training stations these newly recruited men are again studied and many of the unfit eliminated during their period of training

### Dental Service

As has been mentioned the Dental Corps consists of dental officers in proportion of one to every 500 men of the Navy The dental officers furnish complete dental care Great attention is given by the Dental Corps to prophylaxis and the prevention of various dental diseases and the relationship of dental infections to general pathologic conditions

### Medical Service with the Marine Corps

It generally is not realized that the medical service of the Marine Corps is supplied by the Medical Corps of the Navy Yet thi i the ca e and to provide this service an organization of medical troops similar in general character to that of Army

units but still retaining special Naval features is required The organization of these units is too extensive a subject to go into in detail but it will suffice to say that the medical service of the Marine Corps is almost a separate specialty of naval medicine in itself

### NAVAL MEDICAL SUPPLY DEPOTS

The Navy has several large depots and storehouses from which medical surgical and ho pital supplies and equipment are purchased for use in the Navy These depots are respon sible not only for the purchase and accounting of supplies but also for the testing of materials obtained to make sure that they meet specifications The depots are also responsible for the filling of requisitio s and the shipments of these supplies to hundreds of medical department units throughout the Navy

### NAVAL RESERVE

The Naval Reserve is made up of off cers and men who are civilians engaged in civil pursuits The e men are organized into Naval training units to receive short periods of training in duties pertaining to various branches of the Naval Service In the case of the Reserve force of the Medical Department there are included physicians denti ts pharmacists nurses and trained technicians subject to call in time of national emer gency Ca eful physical and professional selection has been ex ercised in the formation of the Reserve Force of the Medical Department and it often includes the outstanding professional people of a community The medical men and dental officers are frequently o anized into hospital un ts The whole plan i intended to furnish rapid expans on and au mentation of the regular Medical Department in t me of war or s milar national emergencies

### CONCLUSION

It must not be forgotten that the Navy is a m lita y organi zation and that its medical service i organ zed and designed for a military purpose The Navy forms a floating defen e about the nation and its possess o s beh nd wh ch the rdi nary pursuits of the ordinary citizen can be carri d n in af ty

from the attacks of any aggressor And too it must not be forgotten that the essential units of the Navy are not steel ships It is the men who really make a Navy and the maintenance of the health and physical fitness of the officers and men is the primary purpose of the Navy s Medical Department All parts of the medical department are organized with one objective that of maintaining the physical efficiency of the personnel so that the maximum military efforts of the Navy can always be available As Lord Nelson once very aptly said The very greatest thing in the military service is health

units but still retaining special Naval features is required The organization of these units is too extensive a subject to go into in detail but it will suffice to say that the medical service of the Marine Corps is almo t a separate pecialty of naval medicine in itself

### Naval Medical Supply Depots

The Navy has several large depots and storehouses from which medical surgical and hospital supplies and equipment are purchased for use in the Navy These depots are respon sible not only for the purchase and accountin of supplies but also for the testin of materials obtained to make sure that they meet pecification The depots are also responsible for the fillin of requi itions and the shipments of these supplies to hundred of medical department units throughout the Navy

### NAVAL RESERVE

The Naval Re erve is made up of officers and men who are civilians engaged in civil pursuits The e men are or anized into Naval trainin units to receive short periods of training in duties pertaining to various branches of th Naval Service In the case of the Reserve force of the Med cal Department there are included physicians denti ts pharmacists nurses and trained technicians subject to call in time of national emer gency Careful physical and profe sional election has been ex erci ed in the formation of the Reserve Force of the Med cal Department and it often includes the outstand n professional people of a community The medical men and dental officers are frequently organized into hospital units The whole plan is intended to furnish rapid expansion and augmentation of the regular Medical Department in time of war o s milar nat onal emergencies

### CONCLUSION

It must not be forgotten that the Navy i a military organi zation and that its med cal ervice is organized and designed for a military purpose The Navy forms a floatin defense about the nation and its possessions behind wh h th rdi nary pursuits of the ordinary citizen can be carr ed on n afety

from the attacks of any ag ressor And too it must not be forgotten that the essential units of the Navy are not steel ships It is the men who really make a Navy and the main tenance of the health and physical fitness of the officers and men is the primary purpose of the Navy s Medical Depart ment All parts of the medical department are organized with one objective that of maintaining the physical efficiency of the personnel so that the maximum military efforts of the Navy can always be available As Lord Nelson once very aptly said The very greatest thing in the military service is health

# ANESTHESIA IN NAVAL PRACTICE

J R Fulton MD FACS

L A C Med ca C Un ed S tes N vy U.S.S R
ief U ite S es F et

Anesthetic procedures used in our Naval hospitals dispensaries and hospital ships do not differ greatly from those used in civilian hospitals and clinics Our problems there differ in no essential from those in civil practice We have adequate equipment and a trained personnel that has kept pace with the ever broadening field of anesthesia However there are certain factors influencing our choice of anesthetic agents and methods that would tend to explain our preponderant use of local regional and spinal anesthesia We must always be prepared for war Present day naval action presupposes a hi h casualty rate and each combat ship must face the prospect of independent action Casualties cannot always be promptly evacuated for the train of a fleet which includes the hospital ships might be at a distant point or may itself suffer casualties Under these conditions the surgeon of each combat ship must be able to perform traumatic surgery under stress with anesthetic agents which do not require special apparatus or assistants

Combined with regional and local anesthesia the use of *nitrous oxide and oxygen* is highly satisfactory for all general surgical work It would be ideal to have compact portable gas machines at each battle dressing station with trained assistants to operate them However the lack of trained personnel aboard combat hips makes this method of limited value

*Ether* given by the open drop method may be employed where the hazards of fire are not serious Becau e of the relatively wide margin of safety in ether anesthesia enlisted per

Th p sse t ta d h th p t es f th t d t t be t ed fficial flect g th f th N y Dep rtm t th N l Serv t l g

Lundy[2] has emphasized the fact that patients with a hemo globin of less than 50 per cent are exceptionally poor risks The objection to spinal anesthesia in this type of patient can be obviated in the naval service by transfusion prior to opera tion and if necessary by continuing the blood during the operative procedure The blood of all officers and men of the Service has been grouped and this grouping is etched on their identification tags and is also recorded in their health rec ords which accompany the individuals throughout their service careers Suitable donors are available on a moment s notice The debilitated and aged group particularly those with cardio vascular or coronary disease are poor spinal risks Spinal anesthesia is also contraindicated for patients who have spinal injuries or disease of the spinal cord and for those who are ex tremely nervous

**Agents** —*Procaine or Metycaine* —Generally our experi ence with spinal anesthesia has been limited to the use of pro caine metycaine and pontocaine The dose of procaine or of metycaine for spinal anesthesia is as a rule never more than 1 m for each pound of body weight The total amount ad ministered does not exceed 200 mg in the case of procaine or 150 mg when metycaine is used It has been found by experi ence that for pinal anesthesia 10 to 20 per cent less of mety caine than of procaine is needed for the average upper ab dominal operation We prefer to use procaine in those pro cedures which may be completed in less than one hour and in which no more than 150 mg of the drug is required to secure adequate anesthesia It has been found that concentrations of 3 5 to 5 per cent procaine or metycaine in spinal fluid give a most satisfactory anesthesia Concentration greater than 5 per cent have not improved the efficiency of anesthesia and we are under the impression that when solutions of greater concen tration have been used there has been a marked increase in the amount of postoperative ileus With the use of metycaine we have ecured satisfactory anesthesia and relaxation in pro cedures lasting one and one-quarter hours to one and one half hours

sonnel can be trained fairly easily in its administration The danger of fire and explosion renders combustible gases such as *ethylene* and *cyclopropane* unsuitable aboard combat ships

*Regional anesthesia* supplemented by pentothal sodium given intravenously would appear to be ideal under combat conditions if personnel with sufficient training were available to give the latter drug

These conditions make it evident that the Navy is in need of surgeon anesthetists who are well trained in the technic of administration of local regional spinal and intravenous anesthesia At our Naval hospital we endeavor to train our medical officers in the use of these method of anesthesia

### SPINAL ANESTHESIA

Generally throu hout the Navy spinal anesthesia is the anesthesia of choice for all operations below the diaphragm unless there are definite contraindicat ons to its u e In 1939 there were 3075 operations performed on Naval personnel under spinal anesthesia

**Advantages**—There are several defin te reasons for the predominant u e of th s method Our service patients are healthy robust young adults who tolerate spinal anesthesia extremely well and who seldom show any of the toxic manifestations of the drug Becau e of the exigencies of the service operations must be performed aboa d ships at a and in dispensaries of i olated naval stations where there may be at the most two medical officers in attendance It i nece sary under these circumstances for the surge n to as ume the re ponsibility of the anesthesia as well as that of the operation Mo t observers are agreed that no ane thesia so easily provides su h widespread mu cular relaxation intestinal qu et and easy recovery as does spinal anesthesia Patients ope ated under spinal anesthesia require very little po toperative nursin attention and this becomes a factor aboa d ship where facil ties may be quite limited

**Contraindications**—Spi al anesthesia is contraindicated in patients in se ere shock particularly because of blood loss

Lundy[2] has emphasized the fact that patients with a hemoglobin of less than 50 per cent are exceptionally poor risks. The objection to spinal anesthesia in this type of patient can be obviated in the naval service by transfusion prior to operation and, if necessary, by continuing the blood during the operative procedure. The blood of all officers and men of the Service has been grouped, and this grouping is etched on their identification tags and is also recorded in their health records which accompany the individuals throughout their service careers. Suitable donors are available on a moment's notice. The debilitated and aged group, particularly those with cardiovascular or coronary disease, are poor spinal risks. Spinal anesthesia is also contraindicated for patients who have spinal injuries or disease of the spinal cord and for those who are extremely nervous.

**Agents.**—*Procaine or Metycaine.*—Generally, our experience with spinal anesthesia has been limited to the use of procaine, metycaine and pontocaine. The dose of procaine or of metycaine for spinal anesthesia is, as a rule, never more than 1 mg. for each pound of body weight. The total amount administered does not exceed 200 mg. in the case of procaine or 150 mg. when metycaine is used. It has been found by experience that for spinal anesthesia 10 to 20 per cent less of metycaine than of procaine is needed for the average upper abdominal operation. We prefer to use procaine in those procedures which may be completed in less than one hour and in which no more than 150 mg. of the drug is required to secure adequate anesthesia. It has been found that concentrations of 3.5 to 5 per cent procaine or metycaine in spinal fluid give a most satisfactory anesthesia. Concentrations greater than 5 per cent have not improved the efficiency of anesthesia, and we are under the impression that, when solutions of greater concentration have been used, there has been a marked increase in the amount of postoperative ileus. With the use of metycaine we have secured satisfactory anesthesia and relaxation in procedures lasting one and one-quarter hours to one and one-half hours.

*Pontocaine* —When time-consuming operations are to be carried out we have found the use of pontocaine extremely satis factory Operations lasting up to two hours are completed satisfactorily under this drug In the majority of cases in which pontocaine is used there has been less fall in blood pressure than is seen under procaine or metycaine The dose of ponto caine for upper abdominal anesthesia is usually from 14 mg to 18 mg depending upon the age size and physical condi tion of the patient and the duration of the anesthesia desired We have used the method proposed by Sise of combining dex trose with the pontocaine solution to aid in controllin the level of anesthesia

**Technic** —*Premedication* —The technic used for spinal anesthesia in the Navy is generally uniform The patient re ceives premedication the evening prior to operation which usu ally consi ts of $1^{1}$ grains of *pentobarbital sodium* or 1 grains of *phenoba bital* by mouth to insure a good night s rest One hour before operation $1^{1}$ grains of pentobarbital sodium are administered by mouth and $^{1}$ to $^{1}{}_{4}$ grain of *morphine sulfate* is given hypodermically Some surgeon anesthetists prefer to give *scopolamine* $^{1}$ $_{0}$ grain combined with the morphine in routine ca es If supplementary anesthesia with an inhalation agent or by the intravenous method is contemplated *atropine sulfate* $^{1}{}_{1}$ $_{0}$ grain is substituted for the scopolamine

*Ephedrine* —Ephedrine sulfate is injected intramuscularly in all cases except tho e with hypertension about ten minutes prior to the time the spinal anesthesia i administered It s our definite impression that we have seen less fall in blood pressure when ephedrine is administered at an interval prior to spinal anesthesia than when it is given at the same time as the pinal injection In the average ca e 25 to 50 mg of ephe drine is used the former dosage being employed in those cases in which the blood pressure i moderately elevated and the latter in cases in which the blood pressure is normal or when larger doses of the anesthetic a e used

*Sites of Injection* —The lumbar interspaces are the usual sites of injection For anesthesia for operation on the uppe

abdomen the first and second lumbar interspaces are used for midabdominal operations the second and third lumbar inter spaces are used for lower abdominal operations and operations about the perineum and the lower extremities the space between the third and fourth vertebrae is used The anesthetic solution is injected slowly and regularly at a rate of 0 5 cc per second Barbotage is not employed

**Complications** —Sise[4] in a recent article has emphasized the necessity for careful attention and supervision of the patient under spinal anesthesia Serious and sudden complications may occur and the anesthetist must ever be on the alert to detect their onset Facilities for the administration of oxygen should be available at all times and ephedrine and neosynephrin should be on hand and ready to stimulate the patient should it become necessary during the course of the anesthesia

*Fall in Blood Pressure* —The most frequent complication of spinal anesthesia is a fall in blood pressure Practically every case shows some slight fall in systolic pressure The fall in blood pressure itself is not always a true indication of the condition of the patient and it in itself may demand no treatment However pallor lessened pulse volume shallow respirations associated with a fairly sharp fall in blood pressure are indications of the need for immediate supportive treatment When these circumstances are present it has been found that 25 mg of ephedrine or 0 1 cc to 0 2 cc of neosynephrin given intravenously will result in a rapid rise of the blood pressure If respirations continue to be shallow or if there is a gradual increase in the amount of intercostal paralysis or if the slightest amount of cyanosis appears oxygen inhalation should be begun at once and continued until the condition of the patient improves Oxygen to control thi depre sion in the re piration may be supplied either by simple inhalation or by exerting pressure on the breathing bag of the gas machine

*Nausea and Vomiting* —Nausea and vomiting is a complication that is seen particularly in upper abdominal operations It is annoying to the surgeon and uncomfortable to the patient This complication may be due to the anesthesia it elf or to the

*Pontocaine* —When time-consuming operations are to be carried out we have found the use of pontocaine extremely satisfactory Operations lasting up to two hours are completed satisfactorily under this drug In the majority of cases in which pontocaine is used there has been less fall in blood pressure than is seen under procaine or metycaine The dose of pontocaine for upper abdominal anesthesia i usually from 14 mg to 18 mg depending upon the age size and physical condition of the patient and the duration of the anesthesia desired We have used the method proposed by Sise of combining dextrose with the pontocaine solution to aid in controlling the level of anesthesia

**Technic** —*Premedication* —The technic used for spinal anesthesia in the Navy i generally uniform The patient receives premedication the evening prior to operation which usually consists of $1^{1}$ grains of *pentobarbital sodium* or 1 / grains of *phenobarbital* by mouth to insure a good night s rest One hour before operation $1^{1}$ grains of pentobarbital sodium are administered by mouth and $^{1}$ to grain of *morphine sulfate* i given hypodermically Some surgeon anesthetists prefer to give *scopolamine* grain combined with the morphine in routine cases If supplementary anesthesia with an inhalation agent or by the intravenous method is contemplated *atropine sulfate* $^{1}$ 0 grain i substituted for the scopolamine

*Ephedrine* —Ephedrine sulfate is injected intramuscularly in all cases except those with hypertension about ten minutes prior to the time the spinal anesthesia i administered It i our definite impression that we have seen less fall in blood pressure when ephedrine is administered at an interval prior to spinal anesthesia than when it is given at the same time as the spinal injection In the average case 25 to 50 mg of ephedrine is used the former dosage being employed in those cases in which the blood pressure i moderately elevated and the latter in cases in which the blood pressure i normal or when larger doses of the anesthetic are used

*Sites of Injection* —The lumbar interspaces are the usual sites of injection For anesthesia for operation on the upper

abdomen the first and second lumbar interspaces are used for midabdominal operations the second and third lumbar inter spaces are used for lower abdominal operations and operations about the perineum and the lower extremities the space between the third and fourth vertebrae is used The anesthetic solution is injected slowly and regularly at a rate of 0 5 cc per second Barbotage is not employed

**Complications** —Sise[4] in a recent article has emphasized the necessity for careful attention and supervision of the patient under spinal anesthesia Serious and sudden complications may occur and the anesthetist must ever be on the alert to detect their onset Facilities for the administration of oxygen should be available at all times and ephedrine and neosynephrin should be on hand and ready to stimulate the patient should it become necessary during the course of the anesthesia

*Fall in Blood Pressure* —The most frequent complication of spinal anesthesia is a fall in blood pressure Practically every case shows some slight fall in systolic pressure The fall in blood pressure itself is not always a true indication of the condition of the patient and it in itself may demand no treatment However pallor lessened pulse volume shallow respirations associated with a fairly sharp fall in blood pressure are indications of the need for immediate supportive treatment When these circumstances are present it has been found that 25 mg of ephedrine or 0 1 cc to 0 2 cc of neosynephrin given intravenously will result in a rapid rise of the blood pressure If respirations continue to be shallow or if there is a gradual increase in the amount of intercostal paralysi or if the slightest amount of cyanosis appears oxygen inhalation should be begun at once and continued until the condition of the patient improves Oxygen to control this depression in the respiration may be supplied either by simple inhalation or by exerting pressure on the breathing bag of the gas machine

*Nausea and Vomiting* —Nau ea and vomiting is a complication that i een particularly in upper abdominal operations It is annoying to the surgeon and uncomfortable to the patient This complication may be due to the anesthesia it elf or to the

surgical procedures that are taking place Sellman has recently reported a series of cases under spinal anesthesia in which pantopon was used as a substitute for morphine in the preoperative medication In this series the use of pantopon rather than morphine apparently had some effect in lessening the incidence of gastric disturbances seen under spinal anesthesia The nausea and vomiting that occur can be completely controlled by light intravenous pentothal sodium anesthesia

*Extremely Nervous Patients* —Occasionally in spite of apparently adequate preoperative medication the patient arrives at the operating room nervous and apprehensive or becomes extremely restless during the course of the operation These extremely nervous patients may be put to sleep with intravenous pentothal sodium before leaving the ward or it may be used during the course of the operation as a supplementary anesthetic Morphine sulfate $\frac{1}{8}$ to $\frac{1}{6}$ grain in 2 cc of distilled water may be slowly injected intravenously before or during any operation under spinal regional or local anesthesia to control exceedingly nervous and apprehensive patients

**Continuous Spinal Anesthesia.**—A discussion of spinal anesthesia would not be complete without mention of the continuous method of spinal anesthesia recently introduced by Lemmon In this method the needle remains in situ during the operation and as the need arises the anesthetist injects additional amounts of the anesthetic solution through a tubing attached to the needle A malleable German silver spinal needle a section of small bore rubber tubing and an operating table cushion with a cut out section to provide space for the needle and tubing are the only special equipment necessary to employ the method

At one of our Naval hospitals we have used this method in seventy six selected cases since July 1940 We have used it mainly in prolonged operations on the stomach or colon There has been only one failure to produce adequate and satisfactory anesthesia and this was apparently due to faulty technic in placing the needle In all our other cases there was no difficulty in maintaining the level and extent of anesthesia necessary and

the operations were all completed under spinal anesthesia The longest operation was of three and one half hours duration The total dosage in this case was 500 mg of metycaine We have used novocain (4 and 5 per cent solutions) and metycaine (3 5 and 4 per cent solutions) We have found that the anes thesia produced by metycaine definitely lasts longer and that the total dosage in the cases in which metycaine was used was less than in operations of the same duration in which novocain solutions were used In our series about 3 cc of the anesthetic solution was necessary to produce initial full abdominal anes thesia Additional increments of 1 cc to 1 5 cc were injected when necessary to maintain the desirable level of anesthesia

*Clinical Value of Continuous Method*—Because of the small dosage of the drug necessary to produce initial adequate anes thesia we have observed very slight if any fall in blood pres sure and pulse and respiration have shown no material changes By withdrawal of the spinal fluid it has been found possible to terminate the anesthesia at any time in a great majority of the cases in which this method is used This would appear to be a very important factor if toxic symptoms should develop The small fractional doses of the anesthetic solution necessary to maintain satisfactory anesthesia the fact that anesthesia may be terminated by withdrawal of spinal fluid should toxic symptoms develop and the fact that prolonged anesthesia may be maintained without apparent danger to the patient would make this method one of obvious clinical value

## LOCAL AND REGIONAL ANESTHESIA

There were 1544 operations (exclusive of tonsillectomy circumcision and other minor procedures) performed on Naval personnel under local anesthesia during 1939 [1]

**Agents**—*Procaine* is considered generally to be the most valuable of all local anesthetic agents because of its compara tively low toxicity and wide margin of safety During the past two years we have used increasing amounts of *metycaine* Metycaine as a local anesthetic has certain advantages It is our impression that it produces anesthesia more quickly more

surgical procedures that are taking place Sellman has recently reported a series of cases under spinal anesthesia in which pantopon was used as a substitute for morphine in the preoperative medication In this series the use of pantopon rather than morphine apparently had some effect in lessenin the incidence of gastric disturbances seen under spinal anesthesia The nausea and vomiting that occur can be completely controlled by light intravenous pentothal sodium anesthesia

*Extremely Nervous Patients*—Occasionally in spite of apparently adequate preoperative medication the patient arrives at the operating room nervous and apprehensi e or becomes extremely restless during the course of the operation These extremely nervous patients may be put to sleep with intravenous pentothal sodium before leaving the ward or it may be used during the course of the operation as a supplementary anesthetic Morphine sulfate 8 to 1 grain in 2 cc of distilled water may be slowly injected intravenously before or during any operation under spinal regional or local anesthesia to control exceedingly nervous and apprehensive patients

**Continuous Spinal Anesthesia.**—A di cu sion of spinal anesthesia would not be complete without mention of the continuous method of spinal anesthesia recently introduced by Lemmon In this method the needle remains in s tu duri g the operation and as the need ari es the anesthetist injects additional amounts of the anesthetic solution throu h a tubing attached to the needle A malleable German silver spinal needle a section of small bore rubber tubing and an operating table cushion with a cut-out section to provide pace for the needle and tubing are the only spec al equipment necessary to employ the method

At one of our Naval hospitals we have used this method in seventy six selected cases since July 1940 We have used it mainly in prolonged operations on the stomach or col n There has been only one fa lure to produce adequate and sat sfactory anesthesia and this was apparently due to faulty technic n placing the needle In all our other case there was no d ft culty in maintainin the level and extent of anesthesia necessary and

half of the skull is to be blocked a semi hatband type of infiltration is used The skin superficial fascia and muscle are infiltrated with the anesthetic solution but it has not been found necessary to inject the periosteum The bones of the skull may be sawed drilled or cut without painful sensation Wounds of the face are easily blocked by regional infiltration across the paths of the sensory nerves

**Neck**—Paravertebral block of the second third and fourth cervical nerves combined with superficial cervical field block will produce sufficient and satisfactory anesthesia for all operations commonly performed on the neck[8] Cervical block in our experience has proved most satisfactory and is our method of choice for all surgical procedures on the thyroid gland

**Chest**—Injuries of the chest including open pneumothorax may be treated by a combination of paravertebral intercostal block and subdermal infiltration Nitrous oxide and oxygen administered under pressure from the gas machine as a supplement to the regional anesthesia would add greatly to the safety in these emergency intrathoracic operations

**Abdomen.**—For penetrating and major abdominal wounds when spinal anesthesia is contraindicated satisfactory anesthesia may be accomplished by a combination of abdominal field block and intercostal nerve block Abdominal field block combined with anterior splanchnic anesthesia by direct subperitoneal infiltration will give adequate surgical anesthesia and marked relaxation With many of our surgeons local anesthesia is the method of choice for such low abdominal operations as appendectomy and the repair of inguinal hernia In any abdominal operation if the local anesthesia is not sufficient it may be supplemented by intravenous pentothal sodium with excellent results

**Rectum and Anus**—In the Navy the great majority of operations on the rectum and anus are performed under regional or local anesthesia Some of our surgeons prefer sacral block others low spinal anesthesia Infected pilonidal cyst is a common occurrence among Naval personnel For these cases low spinal anesthesia is preferred because of the infected field

surely and has a longer duration of action For this reason we believe metycaine is the agent of choice for cervical block paravertebral block block of the brachial plexus and sacral block Clinically metycaine is no more toxic than procaine as a regional anesthetic [7]

**Vasoconstrictors** —Vasoconstrictors such as *epinephrine cobefrin* and *neosynephrin* are incorporated in local anesthetic olutions in order to produce a more lasting effect and improve hemostasis These dru s are usually omitted in local anesthetic procedures on the fingers and toes also in cases with coronary disease or hyperthyroidism Procaine and metycaine solutions should be warmed to body temperature prior to injection The u e of a cold solution is apt to delay the onset of anesthesia

**Preliminary Medication.**—Adequate preliminary medica tion i essential for successful local anesthesia It is important that the patient arrive at the operating room without nervous ness or fear The more commonly used drugs are morph ne scopolamine and several barbituric acid derivatives The chief effects of the barbiturates are to decrease nervousness and to protect against toxic reactions from the local ane thetic agents *Pentobarbital sod um* in doses of 1 to 3 grain is given routinely one and one half hours before operation In addition *morphine sulfate* $^1{}_6$ to $^1{}_4$ grain is administered hypoder mically one hour befo e operation *At op ne sulfate* is usually withheld unless there is the likelihood that supplementary in travenous or inhalation anesthes a may become necessary to complete the operation

**Head** —Recent experiences n Europe have stressed the im portance of local anesthesia in the treatment of war injuries The surgeon anesthetist trained in local and regional anes thesia will accept all lesions of the head neck body and ex trem ties Anesthesia sufficient fo all scalp wound and cran otomy may be accompl hed by the so called hatband type of infiltration This i performed by injecting th anesthetic solution from the glabella over the frontal bone above the eye and around the ear to the occiput The procedure i then con tinued in a l ke manner on the other s de of the head If only

anesthesia which has proved comparatively safe satisfactory and essentially free from complications

**Advantages**—During the past two years an increasing number of Naval medical officers have become familiar with pentothal sodium and the technic of its administration Recent experiences in Europe have brought to our attention its importance in military surgery The introduction of pentothal sodium has given us a drug and a method of anesthesia for war time conditions which in our opinion will be of great value Pentothal sodium administered intravenously produces rapid induction of anesthesia with quick recovery it is fireproof and nonexplosive and does not require elaborate equipment to administer All these advantages would seem to make it a most valuable addition to our armamentarium in mobile hospitals battle dressing stations and in the sick bays of combatant ships where a great number of wounded must be taken care of by a limited medical personnel

**Technic**—We employ the intermittent technic of administration as originally advocated by Lundy using a 2½ per cent solution of the dru It is felt that the 2½ per cent solution has many advantages over the 5 per cent solution With the more dilute solution induction is slower it is felt that the anesthetist has better control of the patient probably less of the drug is used and the danger of phlebitis is minimized

*Oxygen*—It has been found that the continuous administration of oxygen or a mixture of oxygen and nitrous oxide during prolonged procedures under intravenous anesthesia permits more extensive operations than could ordinarily be performed Respirations are more vigorous and can be noted by watching the exchange in the bag of the gas machine When this technic is used more profound anesthesia and relaxation can be secured with apparently less danger of anoxia

**Premedication**—Preoperative medication and preparation of the patient are of the greatest importance The necessity of *atropine* cannot be too strongly stressed Not only does it reduce the secretions of the upper respiratory tract but it lessens the tendency to laryngeal spasm occasionally seen when intra

**Extremities**—Traumatic wound especially those involving severed tendons and nerves and amputations are excellent cases for the use of local anesthesia Difficult identification of the tendons and nerves i made easier when the patient can cooperate in voluntary manipulation of the traumatized extremity Fracture dislocations and traumatized wounds of the *upper extremity* may be succes fully treated under brachial plexus block Unfortunately there i a fairly high percenta e of failure to secure adequate ane thesia with this particular type of block and we feel that a supplementary anesthesia should be available when it i being u ed Naval personnel have a high incidence of traumatized wounds of the *hand* Ulnar and median nerve block at the wri t combined with an annular infiltration at the same level gives e cellent anesthesia for the emergency treatment of these wound

**Fractures and Dislocations**—We have found local anesthesia adaptable to all types of fracture and dislocations One of our med cal officers has reported the use of local anesthesia in the treatment of 200 con ecutive cases of fracture and dislocation without resort to general anesthesia The only requi ite to the use of local anesthes a in these traumatic ca e i the attainment of surg cal cleanliness at the site of the injection of the sterile anesthetic solution Adequate anesthesia can be obtained by the injection of the anesthetic solution into the bellies of the muscles involved in the mechanics of the injury comb ned with a transver e block of the regional en ory nerves about five centimeters above the fracture line It is not necessary to enter the so called fracture hematoma to ecure adequate anesthes a and muscular relaxation

## INTRAVENOUS ANESTHESIA

The first recorded use of ntravenous anesthesia n the Navy was n 1935 when five m nor operations we e performed under intravenous evipal anesthes a *Pentotl al sodu m* was h st used in the Navy n 1938 S nce the introduction of pentothal sodium the intra enous method of anesthesia ha gained rapidly in popularity and p o ided us with a method of general

anesthesia which has proved comparatively safe satisfactory and essentially free from complications

**Advantages**—During the past two years an increasing number of Naval medical officers have become familiar with pentothal sodium and the technic of its administration Recent experiences in Europe have brought to our attention its importance in military surgery The introduction of pentothal sodium has given us a drug and a method of anesthesia for war time conditions which in our opinion will be of great value Pentothal sodium administered intravenously produces rapid induction of anesthesia with quick recovery it is fireproof and nonexplosive and does not require elaborate equipment to administer All these advantages would seem to make it a most valuable addition to our armamentarium in mobile hospitals battle dressing stations and in the sick bays of combatant ships where a great number of wounded must be taken care of by a limited medical personnel

**Technic**—We employ the intermittent technic of administration as originally advocated by Lundy using a 2½ per cent solution of the drug It is felt that the 2½ per cent solution has many advantages over the 5 per cent solution With the more dilute solution induction is slower it is felt that the anesthetist has better control of the patient probably less of the drug is used and the danger of phlebitis is minimized

*Oxygen*—It has been found that the continuous administration of oxygen or a mixture of oxygen and nitrous oxide during prolonged procedures under intravenous anesthesia permits more extensive operations than could ordinarily be performed Respirations are more vigorous and can be noted by watching the exchange in the bag of the gas machine When this technic is used more profound anesthesia and relaxation can be secured with apparently less danger of anoxia

**Premedication**—Preoperative medication and preparation of the patient are of the greatest importance The necessity of *atropine* cannot be too strongly stressed Not only does it reduce the secretions of the upper respiratory tract but it lessens the tendency to laryngeal spasm occasionally seen when intra

**Extremities** —Traumatic wounds especially those involving severed tendons and nerves and amputations are excellent cases for the use of local anesthesia Difficult identification of the tendons and nerves is made easier when the patient can cooperate in voluntary manipulation of the traumatized extremity Fractures dislocation and traumatized wounds of the *upper extremity* may be successfully treated under brachial plexus block Unfortunately there is a fairly hi h percenta e of failure to secure adequate anesthesia with this particular type of block and we feel that a supplementary anesthesia should be available when it is being u ed Naval personnel have a high incidence of traumatized wound of the *hand* Ulnar and median nerve block at the wri t combined with an annular infiltration at the same level gives excellent anesthesia for the emergency treatment of these wounds

**Fractures and Dislocations** —We have found local anesthesia adaptable to all types of fractures and dislocations One of our medical officers has reported the use of local anesthesia in the treatment of 200 consecutive cases of fracture and dislocation without resort to general anesthesia The only requi ite to the use of local anesthesia in these traumatic ca es is the attainment of surgical cleanli ess at the site of the injection of the sterile anesthetic solution Adequate anesthesia can be obtained by the inject on of the anesthetic solution into the bellies of the muscles in olved in the mechanics of the injury combined with a transverse block of the reg onal sensory nerves about five centimeters above the fractu e l ne It i not necessary to enter the so called fracture hematoma to secure adequate anesthesia and muscula rela ation

## INTRAVENOUS ANESTHESIA

The first recorded use of intravenous anesthesia in the Navy was in 1935 when five mi or operat on were perfo med under ntravenous evipal anesthesia *Pe tothal sod n* was first used in the Na y in 1938 Since the int oduction f pentothal sodium the intra eno s method of a esthe a has gained rapidly in popularity and provided us w th a method of general

great extent in transurethral and cystoscopic operations and manipulations

*Fresh Burns etc* —Pentothal sodium is our anesthetic of choice in the treatment of fresh burns especially those contaminated by grease or fuel oil also in such minor procedures as the opening of abscesses removal of packing the dressing of large denuded surfaces and other painful procedures

**Contraindications** —Until quite recently most observers have agreed that pentothal sodium should not be administered to patients who have been receiving sulfonamides unless the latter drug had been withdrawn at least twenty four hours before operation Of definite interest and importance from a naval and military standpoint are recent reports from England [4] which would appear to indicate that pentothal may be used in combination with the sulfonamides with no ill effects Intravenous pentothal sodium anesthesia is contraindicated in cardiorespiratory diseases associated with dyspnea It should not be used in operations in which it would be difficult to maintain a free airway and in cases in which blood and mucus may act as a potential obstruction in the airway Except for the most brief and minor procedures pentothal sodium sould not be given intravenously unless the facilities for administering oxygen and carbon dioxide are available

## SUMMARY

Modern naval warfare presupposes heavy casualties Battle conditions aboard a combatant ship limit the choice of anesthetic agents and methods Fire hazards in the battle dressing stations render explosive and inflammable agents unsuitable aboard ship Small compact portable gas machines to supply nitrous oxide and oxygen should be available at all battle dressing stations Local regional pinal and intravenous anesthesia would appear to be the method which are most applicable under combat conditions World affairs are such that the need of surgeon anesthetists trained and experienced in the above methods is quite evident

venous barbiturates are used Sufficient *pentobarbital sod um* to render the patient sleepy before he is brought to the operat ing room give a smoother anesthesia minimizes apprehension and reduces the amount of pentothal required For the average patient 1[1] grains of pentobarbital sodium i given one and one half hours before operation *Atropine sulfate* 1/150 grain is usually combined with *morphine sulfate* 1/6 grain subcuta neously one hour before operation For short operative pro cedures all preliminary medication except the atropine i usu ally omitted The patient should be brought to the operatin room with an empty stomach bladder and rectum

**Indications for Use**—Although the trend in late literature i continually toward di placement of other anesthetic agents by pentothal odium we have found thi method of anesthesia most applicable for short and minor surgical procedures espe cially in cases in which the operation does not involve the re piratory passa es or when extensi e mu cular relaxation particularly abdominal is not requ red

*Supplemental to Other Methods of Anesthesia*—We have found the method of particular value as a supplement to pinal anesthesia when the effect of the latter begins to wear off before the operation has been completed or when annoying nausea and vomiting are present Local and regional anesthesia sup plemented by intravenous pentothal sodium has given u satis factory anesthesia for extensive intra abdominal procedures

*Fractures and Dislocations*—It is an ideal anesthesia for the reduct on of simple fractures and d slocations especially if there is an associated head injury

*Procedu es about the Head*—The method is particularly well suited for operations about the eye and for the treatment of traumatic lesions of the face scalp and neck I operation about the head it remo es the anesthet st and the equipment from the operative field and lesse s the dan e of contamina tion

*Transurethral and Cystoscopic P ocedu es*—Int avenous anesthesia has d splaced lo sp al and sacral anesthes a to a

# OPHTHALMIC SURGERY IN THE ARMY

FREDERIC H THORNE M D F A C S

L UT C MED CA C U TE ST ES A CH EF EYE,
E N A T SER C S H F S H U
TEX S

---

THE Army offers a fertile field to the medical officer who desires to specialize in the practice of ophthalmology Its possibilities are equal or even superior in many respects to the practice of this specialty in the free and semi free clinics and infirmaries throughout the country The personal interest developed in each case the great variety of conditions encountered and the opportunity to follow each case to its ultimate conclu ion insure one an ophthalmic practice of which any pecialist would be proud The personal interest is markedly developed because the Army is after all one large family regardless of the official status of the individual

The physician who adopts ophthalmology as a specialty assumes a grave responsibility Useful vision on the one hand or blindness on the other in many instances is dependent upon hi judgment and experience and upon his ability to use his hands efficiently The patient with the utmost confidence places his chances of regaining or retaining his vision entirely in the keeping of the physician This confidence becomes apparent particularly in the practice of elective surgery

## THE NEED FOR A SEPARATE BRANCH OF OPHTHALMIC SURGERY IN THE ARMY HOSPITAL

In most of our Army hospitals the eye ear nose and throat pecialties con titute either a separate ho pital service or they

Th p e t t ed h th p at es f th
d t t be t d ff i l fl t g th v s f th
W Dep tm t th m lit y serv ce t larg

## BIBLIOGRAPHY

1 M t nal C mp led F A l R po t f Th geo G ral U S \ 1939 (N t y t i p bl u )
2 Adams, R C d L dy J S F t rs I fl ci g th Ch ce f th A esth ti Ag t d S m S gg ti A esth t T h S Clin N h Amer c 20 915–930 1940
3 Sise L. F P toca gl ose Sol ti f p nal A es hes S C n \ Amer ca 15 1 01 1511 1935
4 Sise L. F Th M g m t f th P ti t d p l A thes S Clin N th Americ 20 631–63 1940
5 Sellm O S S Cl \ Amer 20 621–630 1940
6 Lemm W T A M thod f C tin p l A th ia A S g 111 141 144 1940
7 Tu h E B Th Use f M t ca f P od ing Block A esthes f th Sa ral N rv S g G ec & Obst 68 3 1939
8 W db dge P D R gi l A es hes f Operat th N k S Cli N th Americ 19 53–5 9 1939
9 W ll t M D Loc l A es hes F t R d g th M b d t f T m S gery S rg Cy c & Obst 64 3 5–3 6 193
10 A al Report f Th S rgeo G l U S \ 1935
11 A l R port f Th S rge G ral U S \ 1938
12 L i J S t Ad m. R C I ra A es hesi A es hes l gy 1 145 (Sept ) 1940
13 Ad m R C Rec t Ad A esthesi —1939 A h g 40 364–37 1940
14 Sm h E J R Use f S lf -c t g C mp l P rt l l P t h l Sod m C y h S lf py d B t M J 2 455 (Oct ) 1940
15 \ th M D P th l W S rge y B t Med J 2 842 (Dec ) 1940

# OPHTHALMIC SURGERY IN THE ARMY

FREDERIC H THORNE MD FACS

L C MEDICA C S UNIT S TES A CHIEF E E N AN TH SER S T H ITAL FO T SA HOU ON TEXAS

---

THE Army offers a fertile field to the medical officer who de sires to specialize in the practice of ophthalmology Its possi bilities are equal or even superior in many re pects to the practice of this specialty in the free and semi free clinics and infirmaries throughout the country The personal interest de veloped in each case the great variety of conditions encoun tered and the opportunity to follow each case to its ultimate conclusion insure one an ophthalmic practice of which any specialist would be proud The personal interest is markedly developed because the Army is after all one large family regardless of the official status of the individual

The physician who adopts ophthalmology as a specialty as sumes a grave re ponsibility Useful vision on the one hand or blindne s on the other in many instances is dependent upon his judgment and experience and upon his ability to use his hands efficiently The patient with the utmost confidence places his chances of regaining or retaining his vision entirely in the keeping of the physician Thi confidence becomes apparent particularly in the practice of elective surgery

## THE NEED FOR A SEPARATE BRANCH OF OPHTHALMIC SURGERY IN THE ARMY HOSPITAL

In most of our Army hospitals the eye ear nose and throat pecialties constitute either a eparate ho pital service or they

Th p se t t d h th p at es f th w er l t t be t d ffi l fl t g th ws f th W Dep tm t th m l t ry serv t larg

operate as sections of the general sur ical service but always under one chief and in most instances the personnel is re quired to do both eye and ear nose and throat operations From the standpoint of organization whether the two branches constitute a separate service or not makes little or no difference because to the best of my knowledge there is no handicap at tached to either arrangement What is decidedly important however is the separation of the personnel for eye surgery from that for surgery of the ear nose and throat The two sec tions can function with perfect satisfaction under one head whether or not they operate as sections or as a service but the same surgeon cannot efficiently practice eye and ear nose and throat surgery in the Army at the same time

The particular reasons behind this need for the two branches to be kept distinct are first that there are always more opera tions and clin c treatments in connect on ith disturbances of the ear nose and throat than there are with those of the eye Furthermore the character of the wo k of the one is so dif ferent from that of the other that it i nearly an impossibility for a surgeon to be particularly efficient in both Again the efficient eye surgeon or the ear nose and throat surgeon must possess a particular personality that will permit him to pursue effic ently his chosen work but this per onality is not applicable to eye and to ear no e and throat sur ery alike Because of the amount of work inc dent to ear nose and throat the surgeon i unable to devote sufficient time to ophthalmology since the examinations treatments and sur cal procedu es are painstak ing and require a large amount of time Because the personnel n the Army clinics has been requ red to practice ophthalmology to ether with ear nose and throat surgery it has n most in stances resulted in a large number of particularly well trained ear nose and throat special sts wh le a very small number of surgeons have been able to pract ce ophthalmology sufficiently to become truly profic ent Fu thermore our cl nics n most nstances have been constructed to meet the need of the ear nose and throat section whereas the eye sect on has recei ed little cons derat on Th s condit on howeve i not nece sarily

a serious handicap because by means of a slight rearrangement and some ingenuity a decidedly satisfactory eye clinic can be established with slight expense and labor provided sufficient space is available in the clinic Insofar as ophthalmic equipment is concerned an adequate and efficient supply is always avail able and when it is not placed in efficient use the fault usually lies with the personnel concerned

The aim of the ophthalmic surgeon differs basically from that of the general surgeon in that the former strives to restore or preserve vision while the latter strives to pre erve life The life of the ophthalmic patient is less likely to be at stake and an injury that in another part of the body would be trifling may easily result in total blindness if not carefully and properly handled The blind individual in many respects is the most helpless and dependent of all cripples with which our state or ganizations are burdened

Ophthalmic conditions amenable to surgery as the subject applies to our present Army may be divided into two groups and should we be drawn into war into three groups

## GROUP I OCULAR DEFECTS IN APPLICANTS FOR ENLISTMENT AND IN ENLISTED MEN

Here we may discuss the correction of ocular defects for the purpose of qualifying the otherwise sound individual for the military service or if he is enlisted already to retain him in the service This duty is primarily the responsibility of the civil organizations or of the individual him elf rather than that of the Medical Department of the Army

According to the report of the Medical Department of The United State Army in The World War nearly 4 per cent of the population of military age was found to have erious ocular defects The percentage of the e defects that were potentially capable of correction i not available but con idering the num ber that are to be found in the Army among men called for military ervice today it must have been high

The following ocular defects potentially capable of correction are pecifically di qualifying for the military service

| | |
|---|---|
| Pteryg um encroach g pon the cornea | Chr n d cryocystit s |
| D sfiguring cicat s | Ptosis |
| Symblepharo | P m ent or well marked t abismus |
| Ectropion | D plop |
| Entropion | |

The above defects are disqualifying because of their effect upon efficiency through disf gurement d scomfort and p ychic influence and the possibility that they might lead to an impair ment of visual efficiency sufficiently seve e to make useful serv ice of the individual impossible These defects are potentially capable of correction and in most instances can be corrected by the experienced ophthalmic surgeon It is true that such v ual defects as the suppression amblyop a found in monoc ular strabismus w th first degree fusion cannot be overcome to any great degree but the e cellent cosmetic results that can be attained in the e cases accompanied by some increase in usual eff ciency exert a dramatic psychic effect upon the individual that increase his general efficiency a hundredfold It has been noted in many instances that the correction of a manifest strabismus completely changed the personality of the indi vidual exactly as it has been noted to do so frequently in the case of strabismus n a child The cros eyed soldier seem in ly without a friend in the world has followin a sati factory correction blossomed into a smart and efficient soldier worthy of any organization

The ideal situation insofar as the Army is co cerned vould be for the indi idual to have these defects cor ected while n c vil life but in nearly all instances it i impo s ble for him t do so Cases found in the Army certa nly should be cor ected by the Army ophthalmolog ts and in mo t instance they are and the individuals are returned to duty ather than g ven a discharge for physical disability There emains the quest on whether or not all men with potent ally or ectable defe ts should be admitted nto the service and the necessary corre tions made after admi sion This quest on fo higher author ity to decide but should such men be taken i to the ser ice

without discrimination an important percenta e of physically disqualified individuals would be made available for and able to render efficient ervi e

## GROUP II OCULAR INJURIES AND DISEASES INCURRED IN SERVICE

Ocular defects incurred after entrance into the service may be of any type and severity but the larger percentage of them are traumatic in origin

Ocular injuries that occur when mas es of individual are transported to new environments are necessarily higher than those that occur in civil life and the number of such injuries is again larger in the Army because of the close association of men with machines instruments of war and so forth with which they are unfamiliar Ocular injuries incurred in fistic altercations athletics and automobile and other accidents undoubtedly are about the same in number and severity as those from the same causes in civil life Added to these in the Army however are the ocular injuries incurred in military aviation The number of these injuries is large and they usually are of great severity

Aside from injuries that require surgical interference there are the retinal detachments inflammatory reactions involving the lacrimal sacs inflammatory reactions within the orbits and still other conditions that mu t receive attention The soldier i after all prey to all ocular conditions requirin surgery that are encountered in civil life including cataract and glaucoma

## GROUP III OCULAR BATTLE INJURIES

It is difficult to foretell the number of ocular injuries that may be incurred incident to battle The number of such injuri s incurred in World War I would give one some idea of the number to expect but statistics of these injuries are not available at this time Owing to differences in the methods of conducting the pre ent war as compared with those employed in the war of 1914–1918 the figures of the former would be of questionable value in any ca e However should we be drawn

into the present war the ocular injuries will be many and of every character and every degree of severity that can be imagined Many of these injuries will be so destructive that vision cannot be preserved regardless of the efficiency of the treatment administered Many others will be fatal to vision unless prompt and efficient treatment is administered by an experienced ophthalmic surgeon In still other instances of course men with eye injuries will retain their vision regardless of the type of treatment received Not only will the acute surgical cases present an enormous amount of work but ophthalmic reparative surgery will demand the services of the ophthalmic surgeons to an extent as great if not greater than will the acute phase of treatment

**Gas Injuries**—Apart from gunshot wounds of all de criptions that will be incurred there i always the possibility of poisonous and irritating gases being employed To what extent irritating gases will destroy vi ion i not definitely known since much of their effect depend upon the concentration of the gas and the length of exposure to it as well as upon the character of the gas itself It was noted during World War I that mustard gas seriously affected the eyes of many soldiers

In the past few years the writer has treated one patient whose eyes were injured by smoke and one with tear gas injury and the severity of the injury n each was dependent upon the concentration rather than upon the character of the irritants themselves The first ca e was that of a oldier working at a table on which a sm ke bomb had been placed The bomb rolled from the table onto the floor whe e it e pl ded at the soldier feet He received a considerable bla e f moke in hi face The resultant injurie to h right ye c n i t d of marked conjunctiviti and keratiti ith ulcerat n and late complete ymblepharon of the lo er lid and ner canth s After lon period of treatment the co ea healed the ymblepharon was corrected with grafts and vi ion wa e to ed t 20/40 with correction

The second case to come unde ob vation and t eatment was that of an officer who stooped t pick up a tear gas bomb

from the ground The bomb exploded in his hand and a quantity of the contents struck him in the face He was able to walk to his car and drive himself to the infirmary where he was given first aid treatment and placed in bed Ten days later he was transferred to a general hospital At the time of his admission to the general hospital his eyelids were closed but he could distinguish between light and dark with either eye The lid could be separated slightly revealing a narrow band of clear cornea at the inferior limbus Otherwise the lids were firmly adherent to the globes The upper lid of the left eye was dissected free from the globe up to the fornix and the inner surface covered with a mucous membrane graft secured from the cheek During the dissection the cornea was found to be densely opaque and iris pigment was scattered throughout the adhesions covering the cornea Apparently the cornea was perforated at the time of the injury Whether the globes can be saved and whether eventually keratoplastic operations can be performed remain to be seen

In both these cases insofar as could be determined the injuries were due directly to the gas and not to fragments of bomb casin s or other debris These cases indicate clearly that severe ocular injuries may be and likely will be incurred from irritating gases should such gases be employed

## EXTENT OF OPHTHALMIC PROBLEMS IN OUR PRESENT DAY ARMY

The following statistics may serve as a basis for estimating the number of ophthalmic treatments and operations which are likely to be required in the present day Army In one concentration area with an average military population of 23 500 between January 1 and June 1 1941 4918 patients passed through the eye clinic 113 of them being admitted to the hospital ward Forty nine ophthalmic operations were performed for the correction of defects which existed prior to entrance into the service and ninety three for correction of defects and injuries incurred after entrance into the service All these surgical corrections were considered necessary to permit full mili

tary duty or to preserve or improve vision or in the case of enucleations for acute panophthalmitis and related conditions they were imperative

The operations for the correction of defects existing prior to entrance into the service covered a wide range of conditions including strabismus pterygia chronic dacryocystitis and ectropion with strabismus and pterygia heading the list by wide margins The operations performed for conditions incurred after entrance into the service included extraction of intra ocular foreign bodie enucleations following injuries laceration of cornea and sclera traumatic and senile cataract extractions repair of detached retina and correction of depressed floor of orbit

With few exception correctable ocular defects whether traumatic or otherwise occur in about the same proportions in all parts of the United State When the statistics presented above are applied to the entire Army whose strength is about 1 386 000 at this time it will be seen that in every six months there will be about 2 901 62 ocular treatments or 5 803 21 each year so long as the Army remains at its present strength In every six months there will be 6667 admissions to hospital wards or 13 334 each year for the treatment of ocular conditions There will be about 2891 operations performed every six month or 5782 each year for the correction of ocular defects which existed prior to entrance into the service There will be about 5486 operations performed every six month or 10 974 each year for the correction of ocular defects which were incurred after entrance into the service

The number of refractions performed durin the six months period in the concentration area just mentioned was 676 By the application of thi ratio to the whole Army there will be 39 884 refractio performed every six months or 79 868 each year

## RECOMMENDATIONS

As the Army increa es in e s ill the numbe of ophthalmic operations increase i prop rtion Should we be dra vn into war the Army is likely to inc eas many time o er ts p esent

strength The injuries to be incurred in battle will be nearly unlimited in number and will have to be treated in addition to the load already carried by the Army

**Ophthalmic Centers** —Because of the number of ophthalmic surgeons entering the Army at this time the care of ophthalmic cases is provided for fairly well at least in most areas but it cannot be assumed that the present provisions will be adequate to cope with conditions presented by a greater increa e in the Army and by engagement in active hostilities It is believed that a plan similar but on a larger scale to that used during the war of 1914–1918 if put into effect at once would be satisfactory Under this plan certain large Army hospitals that are distributed fairly evenly throughout the United States would be designated as ophthalmic centers and all ophthalmic cases sufficiently severe to warrant hospitalization for more than a brief period would be transferred immediately to the nearest of these hospitals

These ophthalmic centers would each require an adequate number of thoroughly trained ophthalmic surgeons whose duties would be confined solely to the demand of ophthalmology and to ophthalmic plastic surgery Each center would have to be completely equipped so that all types of ophthalmic procedures could be adequately conducted In addition to the ophthalmologists on duty in these centers there would have to be a sufficient number of technicians trained in perimetry optics orthoptics and related branches Two such technicians in each center would be adequate Nurses are not trained in this type of work and therefore would not meet the requirements

With an ophthalmic personnel as outlined and with adequate equipment and pace the military personnel transferred to such centers for treatment would be assured of receiving the benefit of the best ophthalmic care that can be secured in the United States Furthermore all station hospitals should have on duty a trained ophthalmologist to examine eye cases to determine whether or not the condition warrants the transfer of the patient to the ophthalmic centers Only the trained ophthalmolo-

tary duty or to preserve or improve vision or in the case of enucleations for acute panophthalmitis and related conditions they were imperative

The operations for the correction of defects existing prior to entrance into the service covered a wide range of conditions including strabismus pterygia chronic dacryocystitis and ectropion with strabi mus and pterygia headin, the list by wide margins The operations performed for conditions in curred after entrance into the service included extraction of intra ocular foreign bodies enucleations following injuries lacerations of cornea and sclera traumatic and senile cataract extraction repair of detached retina and correction of de pressed floor of orbit

With few exceptions correctable ocular defects whether traumatic or otherwise occur in about the same proportions in all parts of the United States When the statistics pre ented above are applied to the entire Army who e stren th i about 1 386 000 at this time it will be seen that in every six months there will be about 2 901 62 o ular treatments or 5 803 21 each year so long as the Army remains at its present strength In every six months there will be 6667 admiss on to ho pital ward or 13 334 each year fo the treatment of ocular condi tions There will be about 2891 operations performed every six months or 5782 each year for the correction of ocular defects which exi ted prior to entrance nto the serv ce There will be about 5486 operations performed every six months or 10 974 each year for the correction of ocular defects which were in curred after entrance into the serv ce

The number of refraction pe fo med du i g the six month period in the concentration area just ment oned was 676 By the application of this rati to the whole A my there will be 39 884 refraction performed e e y si months or 79 868 each year

## RECOMMENDATIONS

As the Army ncrea es in size so will the number of ophthal mic operations ncrease propo t on Sho ld we be drawn into war the Army is likely to inc ease many times ver its present

S g al Cl f A th Am n
D mb 1941

# EAR NOSE AND THROAT SURGERY

DANIEL FRANKLIN M D F A C S

LIE T AN C M CA C S U S A ES A WA ER R
GE HOS ITAL, WAS N N D C

---

Surgery of the ear nose and throat will be discussed under two headings namely (1) Routine Surgery and (2) War Surgery

## I ROUTINE SURGERY

Army Regulations specify certain conditions as causes for rejection for military service Some of the more important are (1) acute or chronic suppurative otitis media (2) perforations of the membrana tympani (3) malformations deformities and ulcerations of the nose (4) septal deviations causing obstruction (5) acute or chronic inflammations of the nasal accessory sinuses or hay fever and (6) chronic laryngitis from any cause

**Comparison with Civilian Practice**—The above causes for rejection are enumerated to show that in the Regular Army which is made up of a highly selected group of men only a very limited amount of surgery will be required for chronic disease and the correction of abnormalities as compared with the large amount of surgery needed for such conditions among civilians The surgery indicated for the usual acute conditions of the ear no e and throat differs in no respect from that of civilian practice

During the present emergency the standard of physical requirements for men under the Selective Service Act have been considerably lowered The hurried manner in which large

P bl shed th th pe m f th S geo G ral b th rizati f th B d f R w f M script f P bl t

gist can determine with any degree of accuracy whether or not a given case is serious or potentially serious

**Organizational Problems**—Carrying these recommendations somewhat further it is believed that eye ear nose and throat and maxillofacial surgery should be combined into one service but should function as separate sections within the service All efficient ophthalmic surgeons are trained in ophthalmic reparative surgery All ear nose and throat surgeons are trained in reparative surgery of the nose and ears the maxillofacial surgeon is trained in reparative surgery about the face and jaws The work of these three specialists is closely related and overlaps to a considerable de ree Ofttimes one cannot function efficiently without the skilled help of the others For these reasons it is believed that a decidedly greater degree of efficiency would be attained in the e centers were the three specialties combined into one ervice that is with one co-ordinating head or ch ef of serv ce who would be in charge of the three independently functioning ections

# EAR NOSE AND THROAT SURGERY

DANIEL FRANKLIN MD FACS

LIE C EL M CA C U I S ES A WA ER RE
GENER H PITAL, WASHING ON DC

Surgery of the ear nose and throat will be discussed under two headings namely (1) Routine Surgery and (2) War Surgery

## I ROUTINE SURGERY

Army Regulations specify certain conditions as causes for rejection for military service Some of the more important are (1) acute or chronic suppurative otitis media (2) perforations of the membrana tympani (3) malformations deformities and ulcerations of the nose (4) septal deviations causing obstruction (5) acute or chronic inflammations of the nasal accessory sinuses or hay fever and (6) chronic laryngitis from any cause

**Comparison with Civilian Practice** —The above causes for rejection are enumerated to show that in the Regular Army which is made up of a highly selected group of men only a very limited amount of surgery will be required for chronic disease and the correction of abnormalities as compared with the large amount of surgery needed for such conditions among civilians The surgery indicated for the usual acute conditions of the ear no e and throat differs in no re pect from that of civilian practice

During the present emergency the standards of physical requirements for men under the Selective Service Act have been considerably lowered The hurried manner in which large

P bl shed th th pe m f th S geo G al by a th rizati f th B rd f R i w f M scripts f r Publicat

groups of men are frequently examined and the inequalities in the training and experience of medical examiners in various sections of the country have resulted in the overlooking of many disqualifying otolaryn olog c defects As a result our present Army contains many substandard men It is feared therefore that the experience of World War I will be repeated and that there will be again a large number of men sufferin from chronic diseases of the ear and sinu es requiring hospital ization or prolon ed di pensary treatments These chronic con ditions in the majority of instances have existed for many years—certainly prior to the entrance of the men into the mil tary service It becomes evident that otolaryngologic surgery in the Army will be increased and with few exceptions will approximate more closely that of civilian life

In the military service the medical officer has a duty not only to his soldier patient but al o to the government He must con sider the interest of the service as well as that of the individual before he does certain types of surgical operations For this reason it is considered best to do as few rad cal mastoid ectomies and rad cal s nusotomies with the exception of the maxillary as poss ble It is felt that tho e sold ers who had chronic purulent di charges from the ears or sinu es accom panied by extensive tissue changes pr or to entrance into the military service should prefe ably be discharged for physical disability

**Tonsillectomies** —Another peculiar ty in the military serv ice i the large number of tonsillectom es done on account of repeated attacks of tonsillitis The age g oup the sudden change of climate for many soldiers fatigue e posure the tendency to ignore early syn ptoms the crowdi g in ba racks and the close contact all favor attacks of recu rent tonsill ti There are no available statistics for ton llit in the Surgeon General s Office for the present emergency s nce n the monthly reports tonsillitis is grouped under acute upper resp atory d seases and there has not yet been t me f r endit on of the annual report During the war of 1914–1918 th e re 141 067 primary adm sions to sick report fo acute t ns ll t s fo t oops

in this country alone exclusive of the American Expeditionary Force from April 1 1917 to December 31 1919 The number of tonsillectomies done at that time was very large but exact numbers are not available because one or more monthly reports from almost every hospital failed to reach the Surgeon General s Office Personal communications from the various camps of our present army show an incidence of tonsillitis which approximates that of World War I

The operative technic for tonsillectomy depends on the personal preference of the individual operator Generally it may be said that local anesthesia and some modification of the wire and snare method are used Tonsillectomy patients should be retained in the hospital for about a week after the operation They must not eat at their regular mess or carry out military duties during that period It would be demoralizing for them to loaf in their quarters Late or secondary tonsillar bleeding may occur if the soldier is returned to duty too soon

**Accidents in Camp and Field** —Injurie incident to boxing and other sports as well as accidents that occur while the men are in training are treated according to the accepted methods of civil life In the military service fracture of the nose and other injuries to the face are seen earlier before swelling has taken place and therefore such fractures can be reduced earlier and better results achieved The effect of gunfire on the ears will be discussed subsequently under War Surgery

**Special Instruments** —Before this phase of the subject is dismissed it might be added that each otolaryngologic service i under a competent chief of large experience The surgical equipment and instruments are adequate The sugge tion is made to those otolaryngologists who feel that they must have their particular type of forceps nare curet punch or other instrument that they bring such instruments and appliances with them from their personal collections Certain nonstandard in truments may no longer be procurable in this country If they are available they must be pecially requisitioned and may not reach the hospital until after the particular otolaryngologist who de ires them has been ordered to another station

**Present Status** —To enable surgeons to form some idea of the extent of the operative work done on the ear nose and throat in our new training camps of this country letters of inquiry were sent out The replies showed that during the early part of this year only emergency surgery and a very limited number of elective operations had been done The limited field was attributed to the prevalence of acute upper respiratory disease lack of beds incompletion of operating rooms and so forth However since these replies have been received more normal conditions have prevailed so that almost all diseases and defects that exist in civil life and the operations for this correction are al o to be seen in the military hospital today The great majority of these soldier patients and their newly commissioned surgeons have all been civilians within the year

## II. WAR SURGERY OF THE EAR NOSE AND THROAT

War surgery of the ear nose and throat does not mean any pecial type of surgery It simply means the application of the principles of good surgery to battle and air bombin casualties It is concerned largely with infected penetrating perforatin and mutilating wounds compound fractures foreign bodies hemorrhage and shock It deals also with the deafness that results from the special vulnerabil ty of the ears to the vibrations and sudden variat ons of pressure resultin from gunfire e plosion and concussion

**General Surgical Principles** —In Wo ld War I the otolaryngologist in the United States Ar ry a not called upon often to treat these battle casualtie Usually the general surgeon the faciomaxillary urgeo r e e the b ain urgeon relieved l im of the re pon ibility If the ot lary ologist intend to play a greater role in the future he must familiarize him elf ith modern general surg cal pr nc ple kno a fe mple fact about the elated p cialt es and be familiar with the particular problem presented by each of these special regions

Careful preoperative and roentgen studi s are necessary to determine the nature and e tent of damage cau ed nd how

far treatment must be carried out so that the surgeon can prevent unnecessary harm at operation Attention is to be given to hemostasis relief of pain warmth administration of fluids blood plasma blood typing for later blood transfusions tetanus and gas gangrene anti serum for prophylaxis and chemotherapy with sulfathiazole or the newer drugs depending on the organisms present Wounds are to be cleansed and foreign bodies as well as loose fragments of bone and cartilage if denuded of periosteum or perichondrium should be removed All devitalized tissue should be excised with primary suture only in the limited number of recent injuries that are not deep or extensive In the larger wounds after debridement and the use of antisepsis and chemotherapy supporting sutures should be introduced with emphasis on free drainage

**Nose and Sinuses**—In addition to the general surgical principles already enumerated a few points applicable to particular regions may be suggested In nasal injuries if the bony and cartilaginous portions of the nose are involved the surgeon should save all of the loose bone and cartilage to which there is still an attachment of periosteum in order to build up the framework as much as possible and to make easier the plastic reconstruction later In cases of injury of the nasal meatus large soft rubber tubes should be introduced to maintain patency The nasal septum and turbinates should be replaced if possible and care taken to keep denuded surfaces apart Septal hematomas should be incised early to avoid suppuration and necrosis of cartilage with resulting deformity and even meningitis

In the maxillary sinuses counterdrainage through the nose should always be instituted Great care should be exercised in all manipulations about the ethmoid and sphenoid sinuses for fear of meningitis and injury to the intracranial structure In the case of frontal sinuses the depressed fractures should be elevated and drainage through the nose undertaken Money[4] stated that if when fragments are lifted the dura is exposed and is seen to be bluish or yellowish—even if it is not lacerated—the surgeon must recognize that a subdural hematoma is

likely to be present The dura should not be incised through an infected wound only through a clean wound and the blood and pulped brain substance allowed to escape Any bleeding that occurs from an associated lacerated venous sinus is best controlled by a piece of hammered out muscle graft kept in place for about ten minutes by digital pressure over cotton wool patties until it has stuck fast Before the graft is applied to the sinus the intracranial venous pressure may be lowered by rais ing the patient s head At times it will be necessary to li ate or pack the sinus

**Soft Parts of Mouth and Throat**—Injuries to the soft parts of the mouth and throat are best treated by debridement with retention sutures if the edges of the wound cannot be ap proximated by free drainage and frequent change of dressin s Later mechanical appliances must be devi ed to be used as splints to retain position and contour It must not be forgotten that the pat ent should be fed throu h a nasal feeding tube

**External Ear**—Wounds of the external ear are treated con servatively by primary suture to prevent g eat loss or defor mity with no penetration of cartilage by the sutures The plastic recon truction of an outer ear i very d ff cult In wound of the external auditory meatu after the removal of the foreign bod es the walls should be replaced and rubber tubing of the same caliber introduced for about forty ei ht hours to retain the patency of the canal as well as to afford draina e and pre vent later stenosis Penetrating wounds of the mastoid and temporal bone are treated in general as outlined except that since the introduction of the sulfonamide drugs operation can be delayed until the patient i well over shock and one can wait as lon as forty eight hou s

In all injuries to these special regi ns it must be realized that the injuries f om missiles or p ojectiles d not confine them elves to the areas of this particular spec alty but are fre qu ntly associated with compl cating injuries m dangerous to the patient s l fe espec ally skull f acture a d b n inju ies Accord ng to German statistics of casualties in the p esent war two third of all their battle fatalities resulted f om this class

of injuries Therefore it is believed to be best to segregate these patients in special hospitals or at least to have special teams to deal with this class of battle injuries

**Larynx** —Injury to the larynx usually results in death and therefore must be considered as an emergency from the start Everyone connected with the case beginning with the litter bearers should be made to realize the gravity of this emer gency The patient should not be permitted to talk and should be given morphine and atropine as soon as possible No food or drink by mouth should be permitted since the esophagus might also be injured Falk suggested that it is best to carry the patient with the head bent backwards since this causes pressure of the larynx against the cervical spine thus widening the airway This position permits easier breathing and helps to control the bleeding by compression The associated hemor rhage might be controlled by compression of the carotid artery against the transverse process of the sixth cervical vertebra with local tamponade and possibly ligation of the damaged vessel If the bullet or other fragment has made a hole in the trachea the wound should be cleansed and according to Falk a cannula should be inserted through the opening It is better and safer to do a preliminary tracheotomy in all cases Hemor rhage and rapid asphyxia are the first considerations for treat ment and later such complications as subcutaneous emphysema cervical and mediastinal infections and pneumonia Despons[6] says that the tracheotomy should be done very low just above the sternal notch to diminish the risk of emphysema and mediastinitis

The exploration as well as the debridement of the laryngeal wound should be conservative If there is an endolaryngeal hemorrhage which cannot be controlled by any other means a thyrotomy is suggested It will permit excision of the damaged mucosa and control of the bleeding there by tamponade or liga ture These wounds should never be sutured but should be drained liberally with frequent aspirations and change of dressings The esophagus should be explored for any damage and a feeding tube inserted through the nose The patients who

recover will require prolonged treatment on account of the re sulting steno is to the airway

Fortunately in modern warfare laryngeal injuries are rare the rate being not more than 3 per 1000 The chin and forward projection of the anterior thoracic wall seem to protect the larynx

### DETONATION INJURIES OF TYMPANUM AND LABYRINTH

Ear injuries from indirect trauma not due to missiles but as a result of gun explosions or detonation of high explosives com pri e a large group of military accidents As these injuries can be considered an occupational hazard a longer discussion of them is warranted

**Rupture of the Ear Drum.**—Colledge quoting Zucker man in a recent experimental study of blast injuries stated that the detonation of high explosives produces a wave of compres ion and then a suction There is first a wave of high pressure followed by a wave of ne ative pressure because the wave of compression reduces the density of the air behind it The two together constitute the blast—the pressure component is the more powerful and shorter of the two whereas the suction com ponent is weaker and of longer duration An ear drum might withstand the force of compression and then be ruptured by the sudden action of the suction in the opposite d rection and for a lon er period or the rupture might be cau ed by com pression and the eversion by the following suction Watkyn Thomas commented that the above effect of high explosives that is alternating wave of pre sure and suction can readily be imagined from the approximately equal number of windows blown in and blown out that a person sees when he walks through a bombed area

Collier in a discus ion of her experiences in Barcelona with air raid bombardments stated that Trueta had made studies of blast effects on the middle ear and had found that they vary accordin to the explosi e capacity of the bomb and the dis tance of the victim from the e plo o Med um bombs of 100 to 300 pounds rupture the ear drums within a radius of 50

feet from where they strike of all those who survive the explosion He found that the tympanic injuries were more frequent in men than in women probably because the latter are more likely to cry out at the approach of a bomb thus maintaining the balance of atmospheric pressure on both sides of the ear drum The practice of placing a pipe or a pencil between the teeth when the fall of a bomb seemed imminent was found to diminish the incidence of tympanic injuries and was widely employed both in the cities and at the front Partitions and walls of buildings protected the individuals against blast effects and because of them the percentage was reduced to 0 5 per cent as compared with 40 per cent of those injured in the street This experience is at variance with the impression gained during World War I that when a soldier was confined in a space such as a dugout both ears drums frequently ruptured while if outdoors only one ear drum was injured

The shapes and varieties of ruptures vary from stellate linear angular transverse to quadrilateral and the edges vary from irregular ragged to everted In some instances large portions of the drum have entirely disappeared Negus has made the important observation that no rupture or perforation ever results in Shrapnell s membrane The damage was always to the tense portion of the membrane This knowledge is very important because if a man claims that the condition of his ears i due to explosion and yet the perforation is found to be in Shrapnell s membrane the surgeon can be certain that the claim is without basis

Trueta reported as the results of his experiences in the Spanish Civil War that of all persons who were the victims of high explosives 30 to 60 per cent also have suffered rupture of the ear drums The e lesions often have been overlooked and consequently neglected until suppuration with its complications of mastoiditis loss of hearing and so forth has occurred Surgeons are therefore urged to examine the ears of all head and bla t casualties as soon as their general condition permits in order to make an early diagnosis and to in titute proper treatment

Practically all surgeons agree that such a ruptured ear drum should be treated similarly to one caused by a skull fracture It should not be syringed and nothing should be introduced into the deeper portions of the canal Only a plug of sterile cotton should be put in the external auditory meatus and changed as frequently a nece sary The patient should be put to bed In the Spanish Civil War in over 200 cases of rup tured ear drums treated conservatively only two instances of chronic suppuration have resulted

**Labyrinthine Injuries** —That damage occurs to the inner ear from the detonation of explosions has been amply proved by experimental anatomical and clinical observation Colledge[7] stated that Prenant and Castex in 1916 submitted rabbits and guinea pi s to artillery fire They found the organs of Corti di organized principally in the f rst and second turns of the cochlea hemorrha e atrophy and shrinking of the nervous elements The stat c portion of the labyrinth however re mained intact Stanger subjected rats to blows on the head of varying degrees of violence The labyrinth was examined in those animals in which there was no fracture and hemorrhages were found in the cochlea principally in the neighborhood of the round window and the first turn of the cochlea

Lurie has demonstrated that in guinea pi s the organ of Corti is thrown off the basilar membrane by the use of sudden intense sounds (120 decibels) the pitch being 400 c p s He also showed that the external hai cells resting on the vibrating basilar membrane are affected first while the i ternal hair cells resting on bone are less subject to the vib ation of the basilar membrane He showed too that a *degeneration of external* hair cells causes loss of hear n of about 20 to 30 dec bel and that the internal hair cells are the ch ef functioning se ory cell in the percept ve type of deafness The internal hair cells respond to intensit es between 30 and 40 decibel above threshold Briefly then a catte ed degeneration of the e ternal hair cell causes slight lo s a more general degeneration *greater loss and* compl te de f ess esults from degeneratio of both internal a d exte nal hair cells The conception that

nerve (perception) deafness is due to actual involvement of the sense organ or the nerve itself has been amply proved by numerous investigators Fraser[7] made microscopic examinations of human ears in four fatal cases and found hemorrhage at the fundus of the internal auditory meatus in three cases in which the fine branches of the cochlear nerve entered the modiolus The lesions may be similar to those of the olfactory nerves in fractures of the anterior fossae of the skull

Though treatment for the deafness resulting from ruptured ear drums is satisfactory no such effective treatment is possible for injuries of the inner ear because in such injuries there is an irreparable damage to the organs of Corti and frequently an associated damage to the brain Unfortunately there is no way to help this type of deafness by treatment or any known type of hearing aid

**Preventive Measures**—*Silencers or Mufflers*—The question comes to mind—can such injuries to the middle and inner ear such as have been described be prevented and how can they be prevented? The first thought is to have this blasting sound stopped at its source to do this it would be necessary to put silencers or mufflers on all guns especially those of a larger caliber so that the ears of the members of the gun crews would be protected The Ordnance experts claim that this action is impracticable and would impair the efficiency of the gun furthermore they state that no type of silencer even for the smaller weapons has been approved by them to date In addition to the danger presented by sounds from guns and explosives the Germans have introduced other terrifying screeching sound made by dive bombing and shells which produce a demoralizing effect Nature has well protected the inner ear against direct external trauma by locating it in the solid portion of the temporal bone but has not been fit to provide it with an automatic voluntary defender against excessive noise comparable to the eyelids which shut off excessive light It becomes evident therefore that the only hope lies in the invention of efficient protection to the ears namely ear defenders

Practically all surgeons agree that such a ruptured ear drum should be treated similarly to one caused by a skull fracture It should not be syringed and nothing should be introduced into the deeper portions of the canal Only a plu of terile cotton should be put in the external auditory meatus and change l as frequently as necessary The patient should be put to bed In the Spani h Civil War in over 200 cases of ruptured ear drums treated conservatively only tv o instances of chronic suppuration have re ulted

**Labyrinthine Injuries**.—That damage occurs to the inner ear from the detonation of explosions has been amply proved by experimental anatomical and clinical observation Colled e stat d that Prenant and Castex in 1916 submitted rabbits and guinea pi to artillery fire They found the organs of Corti di organi ed principally in the first and second turns of the cochlea hemorrha e atrophy and shrinking of the nervous elements The static portion of the labyrinth however remained intact Stanger subjected rats to blows on the head of varyin de rees of violence The labyrinth was examined in those animal in which there was no fracture and hemorrhages were fou d in the cochlea principally in the nei hborhood of the round window and the first turn of the cochlea

Lurie ha demonstrated that n guinea pi the organ of Corti is thro n off the basilar memb ane by th use of sudden intense ound (120 decibel ) the pit h being 400 c p s He also sho ed that the external hai cell resting on the vibratin ba ilar membrane a e aff cted fi st while the i te nal hair cell re ting o bone are le s subject to the vibrat on of the basilar membrane He showed too that a degeneration of e ternal hair cell causes loss of hearin of about 20 to 30 dec bel and that the internal hair cells are the chief funct oning sensory cells in the perceptive type of deaf ess The i ternal hair cells respond to intensit e between 30 and 40 decibel above threshold Briefly then a scatter d degenerat on of the external hair cell causes sl ht lo a more gene al degeneration greater lo s and complete deafness e ults fr m d generation of both internal and e ternal ha cell The c ncept on that

Knudsen gave figures of high insulation as measured in decibels with a Sonotone audiometer for these protectors The writer tested persons of higher than average intelligence with these same plugs after he had given them the two sizes with the printed instructions from the manufacturer as to their insertion The hearing was tested for all frequencies with a Maico audiometer before and immediately after the insertion of the plugs It was found that the degree of insulation varied among those examined but when it was averaged the degree of insulation obtained by the use of these defenders was not impressive The disappointing results were believed due to some extent to the improper insertion of these plugs because of failure to carry out instructions carefully Undoubtedly the main reason for the unsatisfactory results was the impossibility of making these soft rubber plugs fit the different sizes and shapes of the orifices of the external auditory canal This defect appears to be inherent in all ear protectors which have to be inserted into the ear canal

Guild has devoted a great deal of time to the study of this subject He favored the device manufactured by a British firm during the war of 1914–1918 named the Scientific Ear Drum Protector Tommy He has proved in the experimental testing of the efficiency of the various devices by histologic examination that dry cotton was the least effective of them all in stoppin mall detonation waves Yet our troops prefer and u e dry c n almo t to the exclusion of all other forms of
ated al o that a finger tip placed firmly
itory canal is a simple and
can always anticipate the
r hand
ctical ear defender which
not been discovered yet
tive genius of our scien
least some of the exist
l in field trials in which
thi basis suitable ac

**Ear Defenders** —During the war of 1914–1918 a thorou h study was made of this subject and various types of pro tectors were te ted but no definite action has been taken to adopt any of them Personal communications from the various Camp Surgeons throughout the country includin Aberdeen Provin Ground Maryland revealed that only cotton cotton waste gun cleanin patches or the index fin ers are used to block the ears Because there i no official prescribed or re quired precaution in many camps nothing at all is used to protect the ears

Our Air Corps has given up all devices which have to be in erted into the external aud tory canal and are experimentin now at Wri ht Field with helmet flap Davis stated that oil cotton wool or coarse fiber plasticine wrapped in gauze is the most comfortable but the majority of oldiers prefer to stop their ear temporarily with the index fin er Some obturator made of inflammable material which have been used by the British have caught on fire from the flash of a gun The Spaniard have used an ear protector on the lines of the Mal lock Armstrong defender It con ists of a mall plu with a valve that remains open e cept when the external pressure is increased The rubber plug defenders distributed in England as part of the Air Raid Precautions have not been des ned on similar lines and Collier laments that they are not as ef ficient as the Spanish

Knudsen made a study of all types of ear protectors avail able to him in the United States and in Europe He earched the patent and technical literature and consulted numerous au thorities on the subject He failed to find a single ear defender that appeared to be desi ned in accordance with acoustical transmis sion theory He devi ed a defender called M S A Ear Defender manufactured by the Mine Safety Appl ances Company Pitts bur h Pennsylvania This defender is e sent ally a tapered rubber tube containin an outer barrier of heavy metal and an inner barrier of oft rubber There are thus two barriers or partitions—operated by an air pace—through which the oise mu t penetrate before it can str ke the ear drum

# PLASTIC AND MAXILLOFACIAL SURGERY

ROBERT H IVY MD FACS

C o ME CAL R s C U TT S ES A IY M o C
S GER N AL RESEA H C IL P
MAXILLO IA S ERY SCHOO O MED CIN U IVER TY F P N
YL IA

THE term Plastic Surgery denotes a branch of surgery in which the shifting or readjustment of tissue is undertaken for the treatment of congenital or acquired deformities for the im provement of function comfort appearance or contour In its general acceptance it is commonly limited to restoration or adjustments of any of the tissues of the face and its appendages the mouth excepting the teeth also the female breast and external genitalia and the skin and subcutaneous tissues of the entire body This is the definition adopted by the American Board of Plastic Surgery

## SUBCOMMITTEE ON PLASTIC AND MAXILLOFACIAL SURGERY NATIONAL RESEARCH COUNCIL

Early in 1940 the Division of Medical Sciences of the Na tional Research Council was requested to form a Committee on Surgery for the purpose of advising the Surgeons General of the Army Navy and Public Health Service on surgical prob lems arising in connection with the national emergency The writer was invited to be a member of this Committee to repre ent the field of plastic and maxillofacial surgery Subsequently a Subcommittee on Plastic and Maxillofacial Surgery was formed with the writer as chairman to co operate with those repre enting the Sur eons General in this particular field

**Personnel**—The members of the Subcommittee in addition to the author are John Staige Davis M D Baltimore Mary land Ferris Smith M D Grand Rapid Michigan Percy C Lo ery D D S Detroit Michigan and Jo eph D Eby D D.S Ne York City The members of the Government

## CONCLUSION

It is realized that the entire subject has been treated rather briefly and that there are many omissions It may be said that the main desideratum of the military surgery of the ear nose and throat is the restoration of the soldier to duty within a reasonable time The surgeon should strive to prevent deafness and chronic infections of the sinuses and ears In the treatment of injuries and war wounds he must transform infected wounds into clean ones with little mechanical or chemical injury to healthy tissue Lastly if the patient becomes unfit for further military service he should be given the maximum treatment possible before he is separated from the service for return to civil life

## BIBLIOGRAPHY

1 A my R g l t ns 40–105 Sta d ds f Ph cal E min f E t t th R gul Army N t l G d d O g d R serves S IV IX M y 29 1923

2 M b lizat R gul t 1 9 S V VI W D p tm t A gu t 31 1940

3 Th M d l D p rtm t f h U S Arm in th W ld W V I XI P rt 2 publ.h d 19 4 S ct Ot l ry g l gy G rnment Print g Offi W h ·t 1924

4 M y R A W W ds f th H d Med J A t alia 1 443–446 (M h 30) 1940

5 F lk P Th py f W I j ries f Laryn M d W lt 14 81–84 (J 27) 1940

6 Desp ns J Emerg cy Th p f L ryn l W W ds R d lary 60 733 739 (N ) 1939

7 E I j th C l P p l u d g Ai R d I d ss t th Se t f Ot l gy f th R y l S ci ty f M d cin P R y l S M d 34 5 (N ) 1940

8 L n M H J A usti l S ci ty f Am rica V l 11 N 4 pp 420–426 (Ap l) 1940

9 G t D d N W Lt C l M C U S A my Office Ch f f Air C rp Wash gt D C P l mmunicati

10 D E D D D f ss D t G Fir Med P ess & C cul 204 332 334 (Oct 30) 1940

11 Kn dse V O N l S f t N w F b ry 1939

12 G ld Stacy R W D f d It P A Ot l Rh l & Laryng l 50 (1) 70 (M h) 1941

# PLASTIC AND MAXILLOFACIAL SURGERY

ROBERT H IVY MD FACS

C o MED CAL RES VE C UNI S TES A M R C I IT E ON SUR ERY N AL RES H C CIL P O O MAXILLO IA S R ERY SCHOO MED CINE U IVER O P N YL A

THE term Plastic Surgery denotes a branch of surgery in which the shifting or readjustment of tissue i undertaken for the treatment of congenital or acquired deformities for the im provement of function comfort appearance or contour In its general acceptance it is commonly limited to restoration or adjustments of any of the tissues of the face and its appendages the mouth excepting the teeth also the female breast and external genitalia and the skin and subcutaneou tissue of the entire body This is the definition adopted by the American Board of Plastic Surgery

## SUBCOMMITTEE ON PLASTIC AND MAXILLOFACIAL SURGERY NATIONAL RESEARCH COUNCIL

Early in 1940 the Division of Medical Sciences of the Na tional Research Council was requested to form a Committee on Surgery for the purpose of advising the Surgeons General of the Army Navy and Public Health Service on surgical prob lems arising in connection with the national emergency The writer was invited to be a member of this Committee to repre sent the field of plastic and maxillofacial surgery Subsequently a Subcommittee on Plastic and Maxillofacial Surgery was formed with the writer as chairman to co operate with those representing the Surgeons General in this particular field

**Personnel**—The members of the Subcommittee in addition to the author are John Sta ge Davis M D Baltimore Mary land Ferris Smith M D Grand Rapid Michigan Percy C Lowery D D S Detroit Mi higan and Joseph D Eby D D S New York City The members of the Government

services with whom we have been most directly working are Brigadier General Leigh C Fairbank Dental Corps U S Army Assistant to the Surgeon General Colonel Norman T Kirk Medical Corps U S Army Chief of the Surgical Service Walter Reed General Hospital Lieutenant Colonel Roy A Stout Dental Corps U S Army Chief of Oral Surgery Section Walter Reed General Hospital and Commander Frederick R Hook Medical Corps U S Navy Chief of Surgical Service U S Naval Hospital Washington D C

From time to time as circumstances demanded other members of the Government services and the National Research Council have sat in the meetings of our Subcommittee It will be noted that the Subcommittee and its Government associates include representatives of both medical and dental professions It has long been recognized that the best results in the treatment of injuries involving the maxillofacial region can be obtained only by close collaboration of the surgeon and the dental surgeon and for this reason any farsighted planning for the care of these cases in wartime must be done by joint action of surgeons and dentists

**Objectives**—The principal problems to engage the attention of the Subcommittee and the interested Army and Navy officers are as follows

1 The formulation of a definite plan of treatment of face and jaw injuries from the first aid stations to the general and special hospitals in the rear

2 The assignment of properly trained personnel to the various units through which such injuries would pass

3 The provision of proper special equipment and instruments needed for the treatment of these injuries

4 The estimation of the number of specially trained medical and dental officers who will be required for this work and the ascertaining as far as possible of the number of already available trained personnel in civil life

5 The preparation of a section on the treatment of face and jaw injuries for the emergency manual to be published by the War Department

6 The preparation of a special Manual of Maxillofacial Surgery to be used specifically in the training of those to be assigned to the treatment of injuries of the face and jaws and as a guide in the treatment of these cases

7 The planning of special courses of training in the care of face and jaw injuries to which medical and dental officers will be assigned

These activities are well advanced at the present time and some of them have been completed The *Manual of Maxillo facial Surgery* regarded as our most important and urgent objective under the able leadership of Dr Ferris Smith is now ready for publication and will be the first of the surgical manuals sponsored by the National Research Council to appear in print

**Suggested Principles of Management**—In the formulation of principles underlying the care of injuries of the face and jaws the best experience with both military and civilian practice here and abroad has been consulted and in the instructions to be given those chosen to care for these cases in our military forces certain definite rules have been laid down A correlated plan of treatment if carried out from the advanced zone to the installations in the rear will greatly shorten the period of disability of patients with face and jaw injuries and a larger number will be restored to approximately normal function and appearance than if haphazard methods are followed At the time of World War I most of our preparations for care of these special cases were made under the able leadership of Colonel Vilray P Blair after the United States entered the conflict In the present emergency should war be declared our plans to care for these cases are well under way and I am of the opinion that we have many more and better trained surgeons and dental surgeons than were available in the war of 1914–1918

The most efficient treatment of face and jaw injuries entail close cooperation between officers of the medical and dental corps The general care of the patient the problems of wound infection and tissue repair will be largely in the hands of the

medical officer or plastic surgeon while the special problems of fixation of jaw fractures and care of the mouth and teeth lie within the field of the dental oral surgeon These two men however are not to be regarded as working separately Each must have an understanding of what the other does so that the treatment will merge into a homogeneous entity Provisions are bein made for the assignment of properly trained medical and dental personnel and special equipment to various hospital installation

Instructions are being prepared for the pecial care of these injuries from the first aid stations back to the general ho pital It is realized of course that modern mobile warfare may en tirely disrupt tables of organization planned in advance But some kind of preparation has to be planned and adhered to when circumstances permit although it should be sufn iently elastic to allow for modifications It is al o understood that specialists in the care of fa ial injuries cannot be assigned as such to the advanced regimental aid stations Ho ever instruc tions as to what should be done there and what should not be done will be given to commissioned and enlisted personnel at tached to these ad anced posts so that tho e suffering from face and jaw ounds will arrive in the best po sible condition at the hospitals in the rear Such a program will probably save many lives and facilitate the later treatment of face and jaw wounds by the specialists

*First Aid Packet*—Every officer and enli ted man of the medical depa tment in the combat zone is supplied with equip ment useful in rendering fi st aid tr atment for jaw injuries The first aid packet adapts tself admirably for jaw fractures and can be applied suitably to a great many types of gunshot wounds of the face and head The compres sewn to the cen tral portion can be made to serve as a hammock or slin to support the injured structures If the attached bandage is torn lengthw se the dressin becomes an deal four tailed bandage which may be sati facto ily applied and ecured The compres itself can be separated from the bandage and used as an extra packing dressing or support ove any region The safety pins in the first aid packet help to make the d essing secu e

## TREATMENT OF MAXILLOFACIAL WOUNDS IN THE COMBAT AREA

In the combat area the following points demand special attention

1 *Arrest of Hemorrhage*—It may be possible to check hemorrhage temporarily by digital pressure over an artery proximal to the bleeding area The principal points of compression about the head and neck are *external carotid artery*—beneath the anterior border of the sternomastoid muscle just above the level of the thyroid cartilage *facial or external maxillary artery*—lower border of the mandible 3/4 inch in front of an le *superficial temporal artery*—just in front of the tragus of the ear Moderate hemorrhage from a wound about the jaw can usually be checked by pressure from a gauze pack inserted in the wound and held in place by a four tailed bandage Care must be exercised in the application of the pack and bandage so as not to increase any respiratory difficulty occasioned by the nature of the wound itself Hemorrhage that cannot be checked in this way demands a search for the bleeding vessel and application of a clamp to it followed by ligation if ligature material is available otherwise the clamp should be left on during transportation of the patient to the advanced hospital

2 *Provision of Adequate Respiratory Airway*—Loss of bone and muscle attachment frequently results in loss of control of the tongue with danger to respiration This danger is best controlled by use of a long suture through the tip of the tongue The suture should be long enough to draw the tongue forward and may be attached to the dressing or clothing If a needle and suture are not available the tip of the tongue may be transfixed with a large safety pin A piece of gauze or bandage may be attached to the tongue suture or safety pin for traction to improve and clear the air passage These considerations are particularly important if the patient is unconscious In other cases due to swelling of the soft tissues sufficient airway can be provided by insertion of a rubber tube through the nose or mouth to the nasopharynx If these means are not adequate tracheal puncture through the skin with a special trochar will usually save the situation It is hoped that these tracheal

trochars will be added to the emergency kit Tracheotomy should be considered only as a last resort since it is followed by a high mortality in cases of thi type

3 *Temporary Approximate Reduction and Fixation of Bone Fragments* —If a dental surgeon i available and time permits he should be assigned the problem of temporary fixation Each dental surgeon at advanced stations i provided with an emer gency maxillofacial kit which contains instruments and ma terials for emergency dental operations and for application of temporary fixation of fractures of the jaws Intelli ent emer gency treatment reduces the period of hospitalization and en sures far greater success in sub equent treatment with a min imum of deformity

Early treatment should ensure every chance for restoration of the original occlusion of the teeth or the restoration of the function of mastication even in those ca_es in which a consid erable amount of bone has been lost It is particularly important that the collap e of bone egments be avoided In order to minimize infection early cleansing of the wound is important Tooth fragments foreign matter completely detached particles of bone and so forth should be removed Often overenthusi astic débridement is instituted with the result that bone fra ments which still possess periosteal attachment are taken away Bone fragments which have any attachment to the soft tissues should be allowed to remain as they frequently keep the r vitality and aid in re tor ng continuity of bone It i much wiser to lea e a bone fragment of doubtful vitality and remove it later in case of necrosis than to pe form a radical removal of all loose pieces of bone because of the resultant defects that may require bone grafting later

Reduction of fragments by manipulat on and temporary fixation by the use of s mple measures such as bandaging and elastic traction should be done if possible at this time Teeth of the same jaw may be wired across the li e of fracture in some cases to mainta n fragments durin e acuation of patients to the rear but fixation of the lower to the upper teeth should never be done prior to unattended travel F xation and stabili

zation of fragments at this stage of the treatment help to reduce pain and shock They also assist in the control of the tissues es ential for the maintenance of a clear air passage and reduce the danger of recurrent hemorrhage

Military conditions may permit the application of some of these fixation measures by the dental officer in the combat zone If they do not the application of fixation measures must be deferred until the wounded man reache the surgical hospital or the evacuation hospital Special apparatus and methods of fixation of jaw fractures by the dental officer are described in the section on Dental Surgery

4 *Provision of Dependent Drainage*—The closure of soft tissue wounds about the jaws by suture is rarely possible at the battalion aid stations but should such occasion present itself officers are warned never to close a wound that communicates with the lower jaw or with the oral cavity without the provision of adequate dependent drainage In those cases in which this fundamental precept has been ignored disastrous results from overwhelming infection have followed frequently After stabili zation of bone fragments if a large gaping wound is present it is best not to try to close it but to cover exposed bone ends by suturing edges of skin to oral mucous membrane The wound is kept wide open and collapse of the bone fragments is prevented This procedure will minimize infection of bone and soft tissues and will conserve tissue for future repair

5 *Provision of Safe Transportation from the Combat Zone to Hospitals in the Rear*—Casualties must be prepared for safe unattended travel by hospital train to general hospitals Aside from problems of nourishment sedation and prevention of shock special considerations apply to face and jaw injuries One of the lessons learned in past wars was that ambulant or semi ambulant patients with oral or pharyngeal wounds should sit up during evacuation If he must be recumbent the patient should be placed face downward to obviate the danger of ob struction in the air passages On the litter he may be placed with the forehead resting on the strap a space being thus left between the strap and the litter proper for the escape of secre

trochars will be added to the emergency kit Tracheotomy should be considered only as a last resort since it is followed by a high mortality in cases of this type

3 *Temporary Approximate Reduction and Fixation of Bone Fragments* —If a dental surgeon is available and time permits he should be assigned the problem of temporary fixation Each dental surgeon at advanced station is provided with an emergency maxillofacial kit which contains instruments and materials for emergency dental operations and for application of temporary fixation of fractures of the jaws Intelligent emergency treatment reduces the period of hospitalization and ensures far greater success in subsequent treatment with a minimum of deformity

Early treatment should ensure every chance for restoration of the original occlusion of the teeth or the restoration of the function of mastication even in those cases in which a considerable amount of bone has been lost It is particularly important that the collapse of bone segments be avoided In order to minimize infection early cleansing of the wound is important Tooth fragments foreign matter completely detached particles of bone and so forth should be removed Often overenthusiastic debridement is instituted with the result that bone fragments which still possess periosteal attachment are taken away Bone fragments which have any attachment to the soft tissues should be allowed to remain as they frequently keep their vitality and aid in restoring continuity of bone It is much wiser to leave a bone fragment of doubtful vitality and remove it later in case of necrosis than to perform a radical removal of all loose piece of bone because of the resultant defects that may require bone grafting later

Reduction of fragments by manipulation and temporary fixation by the use of simple measures such as bandaging and elastic traction should be done if possible at this time Teeth of the same jaw may be wired across the line of fracture in some cases to maintain fragments during evacuation of patients to the rear but fixation of the lower to the upper teeth should never be done prior to unattended travel Fixation and stabili

with the exception of bone fragments with soft tissue attachment

3 Bone fragments are fixed in approximately normal position by wires on the teeth extraoral appliances and so on

4 Devitalized soft tissue is cut away and torn flaps of tissue are restored to approximately normal positions Edges of the skin and mucous membrane are sutured to cover raw surfaces and exposed bone Never suture soft tissues over collapsed bone fragments

5 Dependent drainage is applied to wounds communicating with the mouth or with bone fragments

6 Sulfanilamide is administered internally and sulfanilamide powder is applied locally to the wound surface

## TREATMENT OF MAXILLOFACIAL WOUNDS AT THE BASE HOSPITALS

The time required for the wounded to reach the general hospital which may be situated 100 miles or more to the rear of the combat zone varies considerably The desirability of rapid evacuation to a place where definitive treatment can be given is obvious The measures already outlined if carried out properly will insure the arrival at the base of a large percentage of patients with jaw injury in good condition for definitive treatment

In the general hospitals every possible facility in the way of equipment and special personnel is provided for the proper care of these cases Each case will be examined jointly by the surgeon and the dental surgeon and a plan for its treatment outlined In the interval between receipt of the wound and arrival at the general hospital the onset of infection is to be looked for hence *measures for combating infection* constitute one of the first considerations on arrival Wounds should be carefully revised foreign bodies previously overlooked should be removed abscesses opened and proper drainage established Local and general chemotherapy should be employed when indicated by cultures Roentgenologic examination will reveal foreign bodies fractured teeth displaced bone fragments and

tion and discharges from the mouth These precautions les en the mortality rate of jaw injuries durin evacuation

The most advanced organization to which it is contemplated that specialists in the care of face and jaw injuries will be at tached is the *surgical hospital* a mobile unit operated in con nection with the clearing station located seven to ten miles to the rear of the front line Each surgical ho pital accordin to the plans will have a maxillofacial team consisting of a sur geon and a dental sur eon trained in the special requirements of treatment of these injuries Here more detailed examinat on of the wound can be given and the patient prepared for safe evacuation to the base *Hemo lage* is permanently controlled by ligation of important bleedin points and general measures for the treatment of shock are applied A more thorou h *cleans ing* of the wound of forei n matter detached bone fragment and shred of devitalized soft tissue is carried out and more stable *fixation of bone fragments* i applied Some attention can then be given to the *si tu ing* of large displaced flaps of soft tissue or to the sutu ing of skin to mucou membrane in gaping wound communicatin with the mouth In these pro cedures the principle of avo d ng collap e of bone fragments by cont acture of soft ti sue should be always kept in mind and dependent drai a e should be provided *D b idement* is not carried out as completely in wounds of the face as it is in wounds of other parts of the body since the vascularity of the parts of the face enables them to resi t infection to a greater extent Expe ience in the treatment of a wounds in Europe indicates the great value of the *sulfon mide dru s* n prevent ing and combatin streptococcus and other infections both when they are taken internally and when they are applied locally to the wound

**Summary of Treatment at Advanced Hospital —**

1 Hemorrha e s permanently controlled by ligat on

2 The wound is cleansed and all e dily discovered foreign bodies completely detached bone fragments and teeth and loose teeth and bone connected with f acture li es are emo ed

with the exception of bone fragments with soft tissue attachment

3 Bone fragments are fixed in approximately normal position by wires on the teeth extraoral appliances and so on

4 Devitalized soft tissue is cut away and torn flaps of tissue are restored to approximately normal positions Edges of the skin and mucous membrane are sutured to cover raw surfaces and exposed bone Never suture soft tissues over collapsed bone fragments

5 Dependent drainage is applied to wounds communicating with the mouth or with bone fragments

6 Sulfanilamide is administered internally and sulfanilamide powder is applied locally to the wound surface

## TREATMENT OF MAXILLOFACIAL WOUNDS AT THE BASE HOSPITALS

The time required for the wounded to reach the general hospital which may be situated 100 miles or more to the rear of the combat zone varies considerably The desirability of rapid evacuation to a place where definitive treatment can be given is obvious The measures already outlined if carried out properly will insure the arrival at the base of a large percentage of patients with jaw injury in good condition for definitive treatment

In the general hospitals every possible facility in the way of equipment and special personnel is provided for the proper care of these cases Each case will be examined jointly by the surgeon and the dental surgeon and a plan for its treatment outlined In the interval between receipt of the wound and arrival at the general hospital the onset of infection is to be looked for hence *measures for combating infection* constitute one of the first considerations on arrival Wounds should be carefully revised foreign bodies previously overlooked should be removed abscesses opened and proper drainage established Local and general chemotherapy should be employed when indicated by cultures Roentgenologic examination will reveal foreign bodies fractured teeth displaced bone fragments and

other matter As the acute inflammation subsides more perma nent appliances for reduction and fixation of bone fragments may be made

The important principle of *early reduction and fixation of bone fragments* should always be observed before attempts at permanent soft tissue repair are made The collapse of under lying bone fragments will thu be prevented In many of the simpler cases of fracture of the jaws fixation can be main ta ned efficiently by wires applied to the teeth combined with elastic traction For the more complicated cases especially those entailing con iderable loss of bone and a prolonged period of fixation special plints have been devised Personnel and equipment for their production will be assigned to the general hospital The dental laboratory will also be prepared to furnish various appliances for the support of skin grafts as well as other aid to the surgeon

After the infection has cleared up the problem of *repair and replace ent of lost tissues* i to be considered The soft tissue repair by means of flaps grafts and other devices may often be undertaken while the fractures are undergoing treatment In about 10 per cent of gunshot fractures of the lower jaw there i so much loss of bone substance that nonunion results in which instances there is the nece sity for bone graftin No attempt at bone graftin should be made until at least three months after di appearance of infection f om the region of the injury

The final steps in the restoration of these pat ents are the provi ion of *art fic al dent es* to replace lost teeth and *pros theses* of various kinds to substitute for mi sin parts that can not be resto ed by surgery

In conclu on v e aga n wish to emphas ze that in prepara tions for the ca e of face and jaw njur es an endeavor is being made to put into effect a continu u logical plan of treatment to be followed fr m the combat z ne back to th final phases of recon truction the ge eral or the special hospital

# SURGERY OF THE CHEST

FREDRIC L CONKLIN M D F A C S

CAPTAIN MEDICAL CORPS UNITED STATES NAVY UNITED STATES NAVAL HOSPITAL SAN DIEGO CALIFORNIA

IN only a short period of time the accomplishments in thoracic surgery have been epoch making and in reviewing the literature one is impressed with the remarkable lowering of the mortality rate in this new field of surgery It was not until 1933 that the first lung was removed but with this accomplishment as a stimulus there has been an increasing number of pneumonectomies until today all large clinics follow this line of treatment

It was during the period from 1933 to the present that the foundation for modern thoracic surgery was established with the result that practically every disease affecting the chest now can be successfully treated surgically It must be remembered however that these spectacular advances could not have occurred had it not been for the improved technic in anesthesia the well established procedures of bronchoscopy esophagoscopy thoracoscopy and bronchography and our knowledge of the dynamics and physiology of the thoracic cavity We have known for some time that maintenance of intracranial pressure balance in intracranial injuries is essential to the life and function of brain tissue and the individual Likewise we have learned more recently that an unbalance in intrathoracic pressure with a visceral shift may be incompatible with the physiology of the thoracic viscera and result in death The dynamics and physiology of the chest must be understood in order to care for thoracic injuries successfully and these dynamics must be heeded whenever the chest is operated on

Elective thoracic surgery should be performed by a surgeon

Th p t t in d h re th p t f th d t t b t d ffcal fl t g th w f th N y D p tm t th N l S t l g

other matter As the acute inflammation ubsides more permanent appliances for reduction and fixation of bone fragments may be made

The important principle of *early reduction and fixat on of bone f a ments* should always be ob erved before attempts a permanent soft tissue repair are made The collapse of under lying bone fragments will thu be prevented In many of the simpler cases of fracture of the jaws fixation can be main tained efficiently by wires applied to the teeth combined with elastic traction For the more complicated ca es especially those entailing considerable lo s of bone and a prolonged period of fixation special plints have been devi ed Per onnel and equipment for their production will be as igned to the general ho pital The dental laboratory will also be prepared to furnish various appliances for the support of kin grafts as well a other aid to the surgeon

After the infect on has cleared up the problem of *repair and replacement of lost tissues* is to be considered The oft tissue repair by means of flaps grafts and other devices may often be undertaken while the fractures are undergoing treatment In about 10 per cent of gun hot fractures of the lower jaw there i so much lo s of bone sub tance that nonunion result in which in tances there is the necessity fo bone graftin No attempt at bone grafti should be made until at least three months after d appearance of infection from the region of the injury

The final steps in the restoration of these patients are the provi ion of *artifi al dentu es* to replace lost teeth and *pros theses* of various kinds to substitute for m s ng parts that can not be restored by surgery

In conclusion we again wi h to emphasize that in prepara tions for the care of face and jaw njuries an endeavor is bein made to put into effect a continuous logical plan of treatment to be followed from the combat zo e back to the final phases of recon truction in the general or the speci l hospital

**Shock.**—Shock which is u ually severe in chest injuries must be treated immediately and before any surgery is resorted to the systolic pressure should be 90 mm of mercury or more the exception to this being in the case of hemorrhage During World War I it was demonstrated that morphine heat trans fusion and the immobilization of fractures when present were of paramount importance in the treatment of shock We now have blood plasma which has had sufficient trial in the present war to demonstrate its merits Because of the simplicity of its administration (grouping unnecessary) accessibility (storage and transportation without refrigeration) and the fact that it will keep for weeks I am of the opinion that the use of plasma in the case of shock will do more towards the saving of life than any other single procedure

Whitby and associates in a survey of serious war and air raid injuries state that the pulse rate is an unreliable diagnostic criterion and that the blood pressure is the most reliable one Further they maintain that plasma and blood are equally ef fective in restoring the blood volume A rise of from 10 to 20 mm of mercury for each pint of blood or plasma given is ex pected

Broster states that for shock and loss of blood plasma or blood should be given in large quantities from the start often as much as five or six pints the aim being to maintain the hemoglobin at 80 per cent

**Hemorrhage**—Troublesome hemorrhage may come from an intercostal internal mammary or pulmonary vessel and if it is profuse immediate surgical interference is indicated Bleeding from an intercostal vessel is the least serious hemor rhage and may be controlled by encirclement of the rib with towel forceps on either side of the vessel Hemorrhage from a pulmonary vessel if at the hilum will probably be fatal before it can be checked however if time and supportive measures permit the lung should be exposed and the bleeding controlled To do this a lobectomy or pneumonectomy may be necessary It seems to be the consensus that intrathoracic hemorrhage is intensified and prolonged by the negative pressure

who specializes in thi work but much thoracic surgery can be done by the general surgeon and much emergency thoracic surgery must be done by the general surgeon and general prac titioner Automobiles and indu tries are daily supplyin an in creasin number of chest injurie and of course war give the *military surgeon the extremes in thi clas of injuries*

Base hospitals during war should have surgical team pe cially trained and experienced for re ional work that is to s there should be the thoracic team head team abdominal team orthoped c team and other necessary teams However it should be under tood that the e team should be available for all en eral work if circumstances demand

Indications for surgery of the chest can be div ded into two main groups (1) injuries (2) disease

## THORACIC INJURIES

In thi group we have (*a*) the injuries which require imme d ate interference in order to save the patient life and (*b*) those which can be treated conservati ely but which may re quire surgery at a later date

Conditions encountered in thi group which may call for surgical interference are

| | |
|---|---|
| Shock | F n body |
| Hem rhag | Wo nds f th h a t |
| Ten pneumotho ax | Emphy m |
| W nds (pen tr ti u k ) | T au ti phyx a |
| C rd c tampo d | T a m t c diaph gmat c her i |
| C hin injur | Chyl tho x |
| P t t n of lu by fr t ed rib | |

It i in these cases that the surgeon s skill judgment and peed may mean life or d ath to the patient The f rst examina tion should be gentle thorou h and rap d but time should be taken to outline on the skin the site of the apex beat and other boundaries Because of the rapid chan es whi h might take place this procedure will be of great alu n sub equent ex aminations especially if the patient is e a uated and seen by another physician

a needle should be inserted into the pleural cavity and con nected to one end of a tube The other end of the tube is placed in a bottle of water that should be situated two feet below bed level

The opening of a *sucking wound* should be sealed over until after the shock period has passed then it should be debrided and closed ti htly thus making it a closed lesion

Three months ago a patient was admitted to the Surgical Service of the Naval Hospital San Diego with an *empyema* of the left side Examination disclosed respiratory difficulty rapid pulse rate and a low grade fever 99 6 F Roentgenologically a left pyopneumothorax with a tracheal and mediastinal shift to the right was revealed Thoracentesis with the removal of pus and air which was under pressure brought immediate tem porary relief

In 1938 at the U S Naval Hospital Philadelphia I per formed a pneumonectomy on a patient with bronchogenic carci noma of the right lung The postoperative convalescence was satisfactory until the fifth day when the pulse rate climbed to 150 Respiratory embarrassment was present in spite of the aid of an oxygen tent *x* Ray studies showed a marked mediastinal shift to the right and the manometer recorded an increase of negative pressure In this case the shift was due to *absorption of air* on the operated side which caused hypotension pneumo thorax Air was introduced into the right pleural cavity fol lowed by immediate relief The patient recovered a second air injection was not necessary

**Penetrating Wounds Foreign Bodies Traumatic Em pyema**.—Kretzschmar in describing the treatment of chest wounds by *artificial pneumothorax* states that this treatment apparently was developed by the Italians in the war of 1914–1918 and has been used by the Spanish during their recent Civil War He further states that injury of the large bronchi was rare in the war in Spain probably because the projectiles pu h them aside Any severe injuries catching a major bronchus would al o catch some large vessels and the patient would soon suffocate in his own blood before treatment could be admin

When surgical interference is not possible the blood in the hemothorax should be a pirated and replaced by air a volume of air 300 to 400 cc greater than of aspirated blood bein u ed During this procedure the patient should be carefully observed for a possible induced tension pneumothorax A manometric reading of the intrathoracic pre sure should be made at the time of air injection A hemothorax should be a pirated dry the procedure bein repeated daily if nece sary I do not agree with some surgeons who are of the opinion that the blood should be left in the chest After its early u efulness as a tamponade has pas ed it is of no further value lying in the pleural cavity It hinders re expansion of the lung and i a rich medium for possible empyema

**Cardiac Tamponade**—Cardiac tamponade can be dia nosed by a falling arterial and a risin venous pre sure The fluoroscope will show a d minished cardiac activity and the heart sound will be ab ent or distant Treatment should be immediate consisting either of a piration or operation Follow ing pericardial a piration if the condition fir t improves and then becomes worse operation i indicated

**Tension Pneumothorax.**—Tension or pre ure pneumothorax with a mediastinal shift calls for immed ate action The shift i due to an increase or decrea e of intrathoracic pressure The increa ed pressure can be caused by either (1) injury with intrapleural bleedin or suckin wou d or (2) *empyema with accum ulation of pus a d air* In these cond tions the shift is away from the involved side It s known as a hypertensive shift

In lobectomy or pneumonectomy there an absorption of air causin an increa e of neg ti e p essure which pulls the mediastinum to the affected side the same a in atelectasi a hypotensive shift The symptoms cou h ng re tles ness tachy cardia and resp ratory d fficulty—a e due to cha in pressure on the lar e e el and to sion of the ve sel a d nerve supply of the card ore pirat ry system If the h ft i due to hemo thorax or hemopneumothorax conservat e treatment such as needl n will suffice If the tens on continu d aft r aspiration

Death is probably due to a local visceral shock from which the vital organs do not recover

**Emphysema**—Emphysema unless it is extensive or involves the mediastinum is not serious When operation is necessary the approach is at the site of the fracture so that a laceration in the lung if present can be repaired Mediastinal emphysema calls for immediate relief by means of a suprasternal inci ion If this does not stop the extravasation of air a thoracic decompression should be done

**Chylothorax.**—Chylothorax is rare and should be treated by aspiration and low fat diet

**Diaphragmatic Hernia**—Diaphragmatic hernia is not an unusual complication and can be diagnosed by $x$ rays Immediate operation is not indicated unless there is strangulation After the patient has recovered fully from the other effects of the injury then hernial repair can be considered

**Summary**—In summary it can be said that the treatment of most chest injuries should be conservative but when intervention is necessary conservative or otherwise it must be resorted to immediately I should like to emphasize the importance of the patient being under constant supervision during the emergency period In cases of shock with hemorrhage plasma or blood transfusions and heat should not be spared Patients in shock when admitted to the Naval Hospital San Diego are placed in bed and the heat from a large electric cast dryer is circulated under the blankets This treatment is found to be far more efficacious than the use of hot water bottles or electric pads as the heat is more evenly distributed and is kept at an even temperature

## DISEASES OF THE THORAX

Diseases of the thorax which may require surgical interference are

| | |
|---|---|
| Empy ma | Atelectasis |
| Abscess | Tumors (th ac c and in |
| Br ch ect sis | t athorac c malig ant |
| Pulmonary tuberculos | and be gn) |

istered *Every open wound should be made a closed wound* by careful debridement and by airtight suturing The Spaniards had an oiled silk dres ing and elastoplast which were carried in the men s first aid equipment ready for immediate use

A *foreign body* embedded in the wound should be extracted and a generous thoracotomy debridement and airtight suturing employed Foreign bodies if not removed may result in serious infection If infection develops the wound should be drained at once

A *fractured rib* penetrating the lung should be reduced mobilizing the lung Fractured ribs and sternum may be held in reduction by towel clips and weight traction This procedure is especially applicable in those cases in which there is a stove in condition

According to Monod *traumatic empyema* is bein treated successfully by drainage sulfanilamide T A T (toxin antitoxin mixture) and anti gas serum He states that those patients suf ferin from traumatic empyema require long periods of obser vation and should be evacuated to the rear slowly I am sure that sulfanilamide will prove to be of more value when used prophylact cally than when used in the treatment of traumatic empyema just as it s in the case of compound fractures

**Concussion Injuries** —Concussion from bombs and explo sives in the present war is so great that persons in the vicinity are injured without actually be ng hit Dean states that evi dence of thoracic injury may be seen without any warnin symptoms followin a blast Routine examination should be made of all who have in any way been involved in bomb blasts The phys cal s gns may be diminı hed movement of the dia phragm fullness of the chest (gi ing t an emphysematous ap pearance) and impa ment of resonance at the bases of the lungs Patients f equently exhib t a balloo ed appearance espe cially at the lower co tal margins In sev re compre sion in juries of the chest there are arying degrees of sceral involve ment that range from uptu e of the h art lung or large vessel to contusion of the viscera all of which a e fatal However the last named condition re eals negat ve findin at autopsy

Death is probably due to a local visceral shock from which the vital organs do not recover

**Emphysema**—Emphysema unless it is extensive or involves the mediastinum is not serious When operation is necessary the approach is at the site of the fracture so that a laceration in the lung if present can be repaired Mediastinal emphysema calls for immediate relief by means of a suprasternal incision If this does not stop the extravasation of air a thoracic decompression should be done

**Chylothorax.**—Chylothorax is rare and should be treated by aspiration and low fat diet

**Diaphragmatic Hernia**—Diaphragmatic hernia is not an unusual complication and can be diagnosed by $x$ rays Immediate operation is not indicated unless there is strangulation After the patient has recovered fully from the other effects of the injury then hernial repair can be considered

**Summary**—In summary it can be said that the treatment of most chest injuries should be conservative but when intervention is necessary conservative or otherwise it must be resorted to immediately I should like to emphasize the importance of the patient being under constant supervi ion during the emergency period In cases of shock with hemorrhage plasma or blood transfusions and heat should not be spared Patients in shock when admitted to the Naval Hospital San Die o are placed in bed and the heat from a large electric cast dryer is circulated under the blankets This treatment is found to be far more efficacious than the use of hot water bottles or electric pads as the heat i more evenly distributed and is kept at an even temperature

## DISEASES OF THE THORAX

Diseases of the thorax which may require surgical interference are

| | |
|---|---|
| Empy ma | Atelectasis |
| Ab ces | Tumors (th ac c and in |
| Br ch ectasis | t athoracic mal gnant |
| Pulmona y tuberculos | and ben gn) |

**The Bronchoscope in Diagnosis and Treatment** —There are three principal methods of treatment in diseases of the chest namely medical bronchoscopic and surgical Many cases require treatment by all three Bronchoscopy has done more toward the rapid advancement in the diagnosis and treatment of these conditions than any other procedure However it must be remembered that improved surgical technic pre and postoperative care anesthesia roentgenography with bronchography and pathologic studies have all played their part By the direct inspection of bronchoscopy obscure pulmonary conditions can be diagnosed accurately as a result proper treatment can be outlined There is nothing of more importance in the diagnosis than to be able to obtain a biopsy specimen bronchoscopically from an endobronchial lesion The bronchoscope is useful in the removal of foreign bodies and in addition it is invaluable in the treatment of pulmonary absce bronchiectasis atelectasis and localized tuberculosis lesions Arbuckle and Stutsman recommend its use to determine the cause and location of unexplained bleeding They claim to have had no unfavorable action and advise that the procedure be carried out while bleeding is active

**Empyema.**—During World War I we learned much concerning the treatment of empyema We learned that if thoracotomy was delayed the mortality rate was much lower There are certain fundamentals in the treatment of empyema which are generally recognized and which should be followed The empyema cavity should be kept thoroughly evacuated by means of repeated aspirations until the pus becomes creamy and difficult to remove Then a closed thoracotomy should be performed By the time this is done adhesions will have formed between the lung and chest wall localizing the empyema and helping to fix the mediastinum I believe nothing is gained by irrigation before this stage has been reached However at this time tidal irrigation may be necessary to remove any thick pus that blocks the tubing Adequate drainage must be maintained A roentgenologic check should be kept on the lung expansion as this expansion must be accomplished before the chronic

empyema stage has been reached The physician should not hesitate in instituting suction or in placing the patient on bottle blowing if expansion is delayed When the lung cannot be expanded to fill the pleural cavity the chest is collapsed to the lung by thoracoplasty as soon as the patient is in condition to withstand the operation

**Abscess** —Pulmonary abscess presents one of the most difficult problems for the thoracic surgeon The mortality rate for the condition is too hi h and continued endeavor should be made to lower it Proper treatment cannot be carried out without an accurate diagnosis as to etiology location and extent of involvement To make an accurate diagnosis bronchoscopy roentgenography and broncho raphy are indispensable Lung abscesses like empyema require adequate drainage which can be accomplished either by the conservative method of bronchoscopic aspiration and postural drainage or by surgical drainage Drainage by thoracentesis should not be performed unless the abscess is large superficial and the lung is adherent to the pleura as there is danger of pyopneumothorax and hemorrhage into the cavity Cutter and Gross are of the opinion that thoracoplasty has no place in the treatment of nontuberculous abscesses The only time that artificial pneumothorax might be justified is when the absce s is centrally located and there is little chance of its rupturing into the pleural cavity When a patient fail to improve under conservative treatment surgical drainage should be employed This should be by the two stage method unless the abscess is large with extensive pleural involvement or the patient i toxic and needs immediate relief

**Bronchiectasis** —Surgery for bronchi ctasi is much more promising than in pulmonary abscess In such cases again the extent of involvement must be estimated accurately Conservative treatment by bronchoscopic and postural drainage is beneficial and is the only procedure for extensive bilateral involvement The removal of three bronchiectatic lobes has been found to be compatible with the patient well being

**Pulmonary Tuberculosis** —*Collapse therapy* the universally accepted sur cal treatment for pulmonary tuberculosis

consists of phrenic nerve block artificial pneumothorax pneumoperitoneum pneumonolysis and thoracoplasty Only durin the last decade has collapse therapy been given sufficient trial for an appraisal of its merits The results have been gratifyin Each procedure has its place and limitations and each case should be individualized to determine the applicability of the various collapse procedures Thi therapy when properly used will place the lung at rest collapse and heal cavitation make the patient afebrile and the sputum negative If it does not accomplish the e things a revision of the collapse therapy must be made with the probability that a more extensive and permanent collap e will have to be done May I al o emphasize that thoracoplasty should be done carefully and in stages—not more than two or three ribs at one time bein resected

**Tumors**—The greatest stimulus to thoracic surgery has been the successful removal of one or more lobes of the lun an entire lung and the removal of mediastinal tumors all of which has been accompl shed since 1931 The progress has been rapid and today all active thoracic surgery clinics operate in these cases The increasin importance of these advances i evi dent when one realizes that from 7 to 10 per cent of all cancers ori inate in the bronchi This rate of incidence is h her than is the rate for malignancy of the rectum and colon Many authorities believe that the number of cases of cancer of the lun is increasing When in addition cons deration is g ven to the fact that a large percentage of the cases upon diagnosi are found to be inoperable then it s real zed that thi condition warrants serious conside ation

When the d agnosis is made *early* a cure can be obtained by means of surgery which is the only treatment to date offerin any hope Six years ago the mortality rate was 100 per cent while in 1940 Graham and Blades had a se ies of leven consecutive total pneumonectomies with only three operative deaths a mortality of 27 per cent Ove holt reports on fifty ei ht collected cases of lung malignancy w th a 65 5 per cent mortality rate and hi own series of fifteen with a mortality of 33 3 per cent

The author has performed five total pneumonectomies all for malignancy of the right lung In the first case the tourniquet mass ligation was used In this case in addition to the bronchogenic squamous cell carcinoma of the right stem bronchus bronchiectasis was present The patient died from acute pericarditis empyema and bronchial fistula Another patient lived seven months finally dying from extension of the process it being necessary at operation to peel the lesion from the first second and third ribs posteriorly This was a so called sulcus or Pancoast tumor The patient showed symptoms which indicated thoracic sympathetic involvement (Horner syndrome)

In one case while the lung was being manipulated during ligation difficulty was encountered in aspirating mucus from the contralateral bronchus Before suction could be re-established respiration ceased the heart went into fibrillation and stopped At this time the bronchus was cleared and oxygen was given intrabronchially The heart was stroked with the finger It started once more to fibrillate and then established its normal rhythm The operation was completed and the patient returned to the ward in fairly good condition but died thirty six hours later Nothing was found at autopsy to account for the death which was probably due to a mediastinal shift or to too much surgery at one time

Another patient was progressing satisfactorily when on the sixth postoperative day he became restless and sodium amytal was prescribed As often happens with this drug it acted as a stimulant instead of a depressant and the patient became hallucinated He died suddenly while struggling with three men who were holding him in bed

A patient referred to previously who had hypotension pneumothorax after pneumonectomy recovered and now three years after operation he is apparently cured In only one case was the posterior approach used it was abandoned because it was found to be more formidable than the anterior intercostal precedure Four thoracotomies were attempted on known malig

nancies of the lung but in each case the condition was found to be inoperable with the mediastinum frozen

The following is recommended in *pneumonectomy* preoperative artificial pneumothorax one sta e procedure anterior third interco tal pace approach avertin and local anesthe ia intratracheal a piration and pre ure control Cyclopropane or gas ether can be u ed to augment the rectal ane thesia Regardle s of the type of anesthesia u ed if the parietal pleura and hilar structures are blocked with local ane thesia there will be much less chance of hock Drainage i inadvi able after lobectomy or pneumonectomy

The outstanding accompli hments in thoracic urgery have been in the treatment of chest injuries the improvement in the mortality rate for lobectomy and pneumonectomy and the surgical removal of media tinal tumor There ha been less advancement in the treatment for cancer of the thoracic e ophagus and in the reduction of the high mortality rate in pulmonary ab ce s The profes ion should become more lun cancer con ciou

## BIBLIOGRAPHY


Al d J h F(ty Y f Th ci S rgery Am J S g **51** 217 4
B t L. R S rgi l Probl ms f th W A g **113** 891 909
C rs J h F I Chri t ph T tbo k f S rg ry W B S d rs C Phl d lph 1939 p 89
De La cet **2** 4 (A g) 1940
Ed rds F R La cet **2** 6 3 (N ) 1940
Elki D C d H M H I j f h Chest A rg **113** 6 5–696
H g C F S rgical T tm t f I j s f th Ch t Am J rg **47** 394–40
Kretzschm C H La cet **1** 83 1940
M d R Presse Méd **48** 3 (Sept.) 1 40
Ostro ski T A h f Kl Ch **188** 09 10
R l J A La cet **2** 63 (J l ) 1940
Wh b L. E. *al* La ce **240** (61 6) 99 1 1
Y Book f C l rgery 93 06– S 1 4 19 9 44 9 1940 64–30

Surgical Clinics of North America
December 1941

# SURGICAL EMERGENCIES OF THE ABDOMEN

GOUVERNEUR V EMERSON M D F A C S

Colonel, Medical Corps U S Army, Chief of Surgical Service
Letterman General Hospital, San Francisco, California

IN military practice owing chiefly to the grouping together of large numbers of young adult males who are in an age period in which certain diseases are more prevalent the rate of admission to hospitals for intra abdominal conditions requiring emergency surgery will be found to be higher than in a civilian community of a corresponding size Particularly is this true of appendicitis and particularly does the problem presented by appendicitis vary from that presented by routine admissions for conditions requiring surgery that is definitely elective in nature Before an emergency operation is performed there are two essentials to provide for—first accurate diagnosis and second the prompt arrangement or preparation for the operation—and with these factors in mind the Surgical Service of an Army hospital is so arranged by the detail of qualified technicians from all surgical sections and from the laboratory and roentgenologic department that diagnostic procedures are immediately available day or night

This arrangement provides the means for an accurate diagnosis adequate preparation of the patient for surgery and the prompt performance of the emergency operation

Close contact is made with the Medical Service for emergency consultation to rule out conditions distinctly medical which may simulate a surgical emergency (pneumonia and coronary thrombosis) and to secure advice in the preparation for

The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the War Department or the military service at large

operation in those cases presentin grave complications and frequently requiring emergency surgery

Appendicitis the surgical complications of peptic ulcer intestinal obstruction and acute cholecystitis are the most frequent conditions of the abdomen requirin emergency operations so in the main most of the problems are clear and easily settled Occasionally by reason of age weakened condition of the patient or attending complications the skill judgment and ability of the most experienced surgeon will be taxed in the management of these emergencies

## APPENDICITIS

Appendicitis i the most frequent intra abdominal pathological condition requiring emergency surgery in military as well as civilian hospital and as the strength of the Army increases o will the number of men needing emergency operations So much has appeared about appendicitis in the literature of recent years from the pens of su geons of great renown that it eems that there i little left to say about this condition yet it continues to take it toll of li es Improvement in surgical technic to ether with recent ad ances in diagnostic adjuncts have not improved the statistics

**The Urgency of Operation**—Appendicitis while not a preventable di ease is one that in the main is relatively easy to diagnose and one that lends itself to cure by a classical procedure if action is taken in time I do not believe that the mortality depend on a particular type of incision a particular method of handling the stump or a particular postoperative regimen but rather upon an early diagnosis and an early operation Axioms ha e no place in teaching or in p actice when appendicitis i dealt with though they may be a valuable aid to their ori inator they a e a distinct haza d when followed by the many and they should not be off ed as means of d f ferential diagnosis or as cocksure rules *D lay* is the greate t sin le factor contributin to the mortal ty of append c ti and no matter where the re pons bility for it rests the final result is the same—an ad an ed state of the d sease c mpl cations

and increa ed death rate It must be insisted upon that the emergency in appendicitis is *early* rather than late and that *the operation must be performed as soon as the diagnosis is made* regardless of the time of day or night and irrespective of the surgeon s other impelling duties or engagements

The only way that suppurative and gangrenous appendicitis can disappear from our classification of this disease is by the exertion of every effort to place these patients in the hands of a surgeon as soon as the early symptoms of appendicitis appear so that he can remove the appendix immediately after the diagnosis has been made

**Mortality** —In the military service owing to the immediate availability of medical attention and provisions for hospitalization for all members of the service patients come under professional surveillance much earlier than in civilian practice Because of these factors lower mortality rates are to be expected Bliss[1] reported ten deaths in 2100 operations for acute appendicitis a mortality rate of 0 47 per cent He concluded that early control of military patients was a factor in the achievement of this low mortality Johnson reported four deaths in 1281 operations for appendicitis on the Surgical Service of a Naval Hospital and on a Hospital Ship of the Fleet He is of the opinion that the provisions for early medical care and hospitalization in the Navy together with early operation were important factors in bringing about the low mortality

In a series of 1254 operations performed on the service of the writer from January 1 1935 to June 1 1940 there were three deaths These figures are representative of the statistics for the Army as a whole During 1939 there were 2124 operations performed in the Army for appendicitis with eighteen deaths In 1940 there were 1999 operations performed for appendicitis with thirteen deaths

**Operative Technic** —Our emergency service is so arranged that all cases of abdominal pain suspected of being surgical are seen immediately by a member of the surgical staff and when appendicitis has been diagnosed immediate operation is performed The McBurney incision is the method of choice in

all ca_es in which the diagnosis is clear-cut the right rectu in cision being reserved for the obese individual and for those ca_es in which the diagno i is in doubt and exploration will be required The stump always is buried except in tho e ca_es in which the cecum is indurated by the inflammation when the free drop method is u_ed after cauterization or carbolization. Spinal anesthe ia is the anesthesia of choice Attempt i made to remove the appendix in all cases but when it is found in an advanced state of inflammation pocketed in an absce s which has not become adherent to the abdominal wall a drain is placed at the site of the ab cess and the appendix is removed at a later date

## ACUTE GALLBLADDER DISEASE

Many controversies till ensue among those of equal experi ence in the surgical treatment of the acute gallbladder the controversial points being the optimum of time for the perform ance of the operation and a definit on of the o-called imme diate or emergency period the early and the delayed periods Although early operation is sub cribed to the individual factors governing in each case should be the guiding influence in this decision

In military ho pitals acute cholecystitis is a fairly frequent cause of admission and its treatment cause the same degree of concern as in c vilian institut ons These patient admitted to the hospital are primarily assigned to the Medical Service and clo e collaborat on with the Surgical Service maintained to determine the best time for surgical intervention in a given case In most in tance these pat ents come unde observation soon after the onset of the di ea_e and thi early ho pital za tion is a favorable influence n the outcome of the di ease

**Immediate Versus Delayed Operation.**—Generally peak ing the term emergency s reserved for th se few cases in which it is apparent that the disease s rap dly progres in and perforation eems imm nent Th s per od p e upp ses operation within an hour or two following admission The p oblem then is to determine the *type of ope at on* best su t d to the case

and in making this important decision one mu t be guided by the condition of the patient and the degree of inflammation present together with the complications encountered

In the surgical treatment of acute gallbladder disease a definite policy that is suited to all the cases cannot be estab lished as can be done for instance in the management of acute appendicitis though the similarity of the inflammatory process has frequently been the basis of argument for the same type of surgical management The two conditions differ considerably in the liberty that may be taken in the delay of the surgical intervention

Few gallbladder conditions with the exception of the perfo rations due to ulceration or suppuration demand emergency operation In those cases that do the speed of surgical interven tion is as important as in any other intra abdominal catastrophe amenable to surgical treatment Most of the gallbladder condi tions will benefit by a period of observation ranging from sev eral hours to several days during which time the body fluids can be restored and preoperative preparation instituted while a safe estimate is made of the surgical requirements This pro cedure puts most of the cases in the so called early group for surgical interference

In the military service (due to the rigid examinations on en trance and periodic examinations while on active duty) the complicating diseases that would influence management of surgical emergencies are undoubtedly less than in civil practice and the patients are in an age group and in physical condition better able to endure the seriousness of the required surgical procedure

**Choice of Operation**—*Cholecystectomy* is certainly the operation of choice if it can be performed with assurance that grave damage will not be done to important nei hboring struc tures which may have become edematous friable and indurated from extension of the inflammation Whether this procedure is accomplished from the cystic duct up or from the fundus down should depend on the findings at operation The latter pro cedure is considered much safer when the gallbladder is dis

tended and friable and when th degree of inflammation makes the isolation of the cystic duct difficult In those cases in which observation reveals that the process has subsided operation can best be performed when inflammation and edema have subsided In all cases drainage of the gallbladder bed by means of a stuffed Penrose drain is recommended

*Partial cholecystectomy* may have to be resorted to in some instances of advanced disease

There will always be patients weakened by prolon ed illness dehydrated by fluid loss or jeopardized by complications whose best interests will be served by *cl olecystosto iy* even though secondary cholecystectomy will have to be performed at a later date Cholecystostomy will suffice in approximately 80 per cent of the cases Secondary operation will be required in the remaining 20 per cent

Surgery in the jaund ced patient is not attempted until suit able therapy with vitam n K and b le salts has restored the prothrombin level to the limits of safety

**Case Report**

A wh te man fo ty one yea s ld w s adm tted to the hosp t l June 8 1941 t 7 00 A M with the ch ef c mpl nt f s ver g eral ed abd minal amps existin since 10 00 P M the n ht before H temp atur was 99 F r sp rat o s 24 pul e 88 face fl hed sk n dry

*H sto y*—The p t nts h st ry eve l d th t e week prev ously h h d been t eated at a othe h sp tal f seve e abdom al p which lasted for tw l e h u s H was eta ed in the ho p t l f r s e l d ys aft pa n d pp a d and pon di harge from th hosp tal he was g l a a d ame t th s ty Foll wing in discretio s in food nd dr nk th p t nt w s se ed w th ttacks of seve e v m ting at abo t 8 00 P M d d n the c ur of one of the omit ttack t 10 00 P M he exp nced a sudden se e e pain in the ep g str m wh ch l t r b c m g aliz d a d d bled up the p t t He had had p e s p in that wo ld y w y s mul te th t from a pept c l

*Laboratory d x R y D ta*—Th p t e t blood co t o ad m ss n was ryth ocytes 4 500 000 leukocyte 21 800 hemoglobin 90 p cent p lym rpho l a s 87 per t lymph cyte 11 pe ce t monocyt 2 pe ce t U ly w s esse t ally neg t e x Ray e m t of the he t h d th h t lun s d

phr gm and pleura to be essentially normal A flat plate of the ab domen was of no d agnost c s gnificance The p ovisional diagnosis was ruptured peptic ulcer

*Expl ratory Operatio* —The abdomen was ope ed through an up per r ht rectus incision There was approximately 500 cc of bile colo ed fluid i the peritoneal cavity and considerable infiltration of the lesser omentum with bile The omentum was slightly adherent in the region of the gallbladder by fresh fibr nous adhesions These were freed and the gallbladder was foun l to be markedly acute and moderately thicke ed There were no sto es palpable The gallblad der was somewhat d stended After the adhesio s were freed the cav ty was explo d throu h the foramen of Winslow Results were negative Duod um and stomach were found to be normal and showed no evidence of ulce ation or perforation It was concluded that the prese ce of bile n the per toneal cavity was due to a spon taneous ruptu e of the gallbladder in the vicin ty of the cyst c duct or p obably in the duct itself

*Chol cystostomy and Results*—A No 18 catheter was placed in the g llbladder a d cholecystostomy was completed The postoper ative course wa ent rely sat factory Operative find ngs ruptured gallbladder with b le per tonit s gen ral zed Operation chole cystostomy Result recovery

## ACUTE INTESTINAL OBSTRUCTION

**Conditions Producing Obstruction**—A wide variety of patholo ical conditions may be the causal factors in this acute intra abdominal catastrophe which is encountered with suffi cient frequency in military hospitals to justify its classification among the serious surgical emergencies Chief of the causal factors are external hernia internal hernia obstruction due to adhesions and bands volvulus intussusception and acute ob struction due to malignant lesions of the lower bowel

*Strangulated Hernia*—Though a frequent cause of obstruc tion in civilian practice especially among patients in the ex tremes of the life span strangulated hernia is much less fre quently seen in military practice owing chiefly to frequent rigid physical examinations and the service requirement of operation as soon as a hernia is discovered the condition un treated bein classified as an incapacitating defect The per centage of refusals of patients to submit to operation there fore is small and we are spared the necessity of educating

tended and friable and when th degree of inflammation makes the isolation of the cystic duct difficult In those cases in which observation reveals that the process has subsided operation can best be performed when inflammation and edema have s h sided In all cases drainage of the gallbladder bed by means of a stuffed Penrose drain is recommended

*Partial cholecystectomy* may have to be resorted to in some instances of advanced disease

There will always be patients weakened by prolon ed illnes dehydrated by fluid loss or jeopardized by complications whose best interests will be served by *cholecystostomy* even though secondary cholecystectomy v ill have to be performed at a later date Cholecystostomy will suffice in approximately 80 per cent of the cases Secondary operation will be required in the remaining 20 per cent

Surgery in the jaund ced patient i not attempted until suit able therapy with vitamin K and bile salts has restored the prothrombin level to the limits of safety

**Case Report**

A wh te man fo ty on yea s ld was adm tt d to th ho p tal June 8 1941 at 7 00 A M w th the ch ef ompla nt of severe generalized abdominal cramps e isti g since 10 00 P M the night befo His tempe tu e was 99 F p at o s 24 pulse 88 face flu hed skin dry

*Histo y*—Th pat e t history e ealed that one week p usly he h d been t at d at ther h sp tal f s r abd minal pa wh ch lasted f twelv hours He as eta d n the h sp tal fo seve al days fte p in dis ppe ed and upo d schar from the hosp tal he was g ve lea e nd came t this c ty F llowing in disc etio s in food and d ink the pat nt w se ed w th attacks f severe vom t g at abo t 8 00 P M a d du g the cou se f on of the v m t g tta ks at 10 00 P M h pe c d dd se re pa n in the ep gast m wh ch l t r became g n l ed a d doubled up th patient He h d had o p vi s pa n that w uld in any w y mulate that f m a pept ulc

*Labor tory a d x R y D t* —The pat t s bl od co nt on d miss on was erythrocytes 4 500 000 l ukocytes 21 800 h moglobin 00 per c t polymorphonucl s 87 p c nt lymphocyt s 11 pe ce t mo ocytes 2 p ce t Uri ly wa e se tially nega t ve x Ray e ami at on of the ch t h wed the hea t l gs dia

Accuracy of diagnosis is nowhere more important than in this type of case the management of which should be entrusted only to those most experienced in the differentiation and evaluation of the complicity of the manifestations Failure to recognize the strangulating types of obstruction in which permanent damage has been done to the vascular distribution of the entrapped loop may spell failure for conservative measures instituted in the belief that operation might have been avoided The operative findings in cases of this type are interesting and diversified They range from simple band or rope adhesions and omental deflections angulating or constricting the bowel to massive adhesions between loops that interrupt intestinal continuity

*Volvulus* —Volvulus of the small intestine is encountered very infrequently and it may vary in extent from the inclusion of a small loop to a massive process involving many feet of the bowel Here again the speed with which the condition is recognized and surgery is instituted spell life or death for the loop involved and success or failure of the procedure to avert a fatality

*Intussusception* —Owing to the fact that intussusception occurs chiefly in infancy and childhood it is not an important factor among the admissions for hospitalization in military practice

*Obstruction in the Large Bowel Due to Malignancy* —Acute occlusion of the bowel by a malignant growth in the splenic region of the colon or in the sigmoid is occasionally the cause of an emergency admission at a time when late distention characteristic of lower bowel obstruction demands emergency decompression It is important in cases of this kind to make a preoperative differentiation between small and large bowel obstruction A flat *x* ray plate of the abdomen is frequently of value in this determination

**Treatment** —It is nowhere more important to make an early and accurate diagnosis than in cases of intestinal obstruction for it is on *successful diagnosis* that successful treatment depend In cases of this kind we must decide between the

patients in the care of hernias the method of reduction and symptoms of strangulation Most patients pre ent them.elves for treatment as soon as the defect i discovered When tran, ulation does occur the case comes under medical ob ervation promptly which means early hospitalization and early opera tion Thus devitalized loops are rarely encountered

*Obstruction Due to Adhesions and Bands* —Adhesions of o e type or another are a frequent cau e of interruption in the con

F 349—St ps h fl t pl f bd m b st ct t f ld pe sca

tinuity of the bowel and recently with the great ncrea e in the stren th of the Army and the co respondin increase in the number of those who have had previou su ge y obstruction from th s source i a much more f equent cause fo admi sion to the hospital Attention we bel eve should always be focused on the scar and an accurate history pe t n nt to the p imary operation should be obtained f om pat ents who p e ent symp toms s mulating obstruction

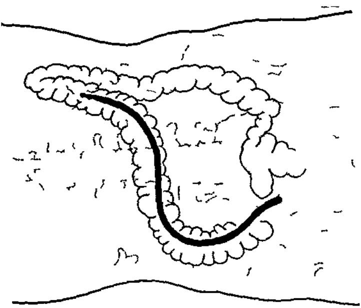
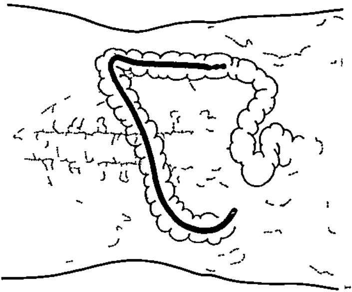


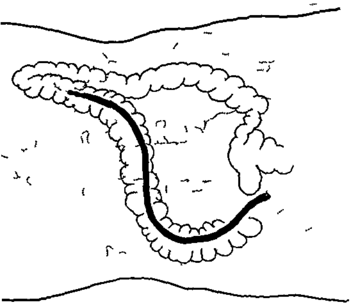
Fig 351 Miller Abbott tube in transverse colon

pend the type of treatment—conservative or operative As mortality is in direct proportion to the time intervening between the onset of the symptoms and the institution of treat



Miller Abbott tube in proximal sigmoid

institution of the newer methods of siphon suction the use of a two-way drainage tube or immediate surgical intervention for on the degree of obstruction and the type of obstruction de



F 351

Miller Abbott tube in transverse colon

pend the type of treatment—conservative or operative As mortality is in direct proportion to the time intervening be tween the onset of the symptoms and the institution of treat

ment it must be realized that any procedure that lengthens th interval will contribute to an unfavorable outcome High mortality in obstruction as in appendicitis and perforation is attributable directly to delay

*Decompression* —The introduction of continuous suction by Wangensteen and the advent of the two way tube of the Miller Abbott type have provided valuable additions to the conservative management of certain types of obstruction particularly of that due to ileus the mortality of which has been greatly reduced by the timely introduction of these method of decompression Attention here must be directed to the importance of differentiating an acute mechanical obstruction from a simple or incomplete type and likewi e from an adynamic ileus for even the most ardent advocates of tube decompression caution against its use in a suspected or known case of stran ulation Failure to make such a differentiation or to use the tube decompression as a preliminary to surgery in the mechanical types of obstruction will prolon the period of delay and will contribute materially to a high mortality The two way tube can be passed great distances and it often decompre se di tended loops as it proceeds in its course ind catin and releasin points of incomplete obstruction Occa onally in large distentions due to constriction near the ileocecal valve the tube may fail to deflate as completely as may be desired We have passed a Miller Abbott tube into the cecum transver e colon and descending colon on several occasions

*Fli ids* —Important in the treatment of obstruction i the replacement of flu ds lost by vomit g or by aspiration in the patients who have had decompressi n Toxemia should be combated by an adequate amount of flu d in the nature of normal saline with 5 or 10 per cent glucose To meet the chlor de lo s hypertonic salt solut ons should be used pa ticularly in cases of h gh ob truction in v hich the vomiting has been severe No matter what the type of obstruct on is the fluid requirements in the indi idual case should be met by nt a enous administration Transfus on may be the d c d g facto i the outcome of any case

*Surgery*—Immediate surgery of the simplest type consistent with the condition of the patient is advocated in all cases of complete occlusion of the lumen of the bowel Release of constricting bands of adhesions in certain cases will alone suffice Primary resection is advocated in all cases in which the viability of the bowel has been lost and in which the condition of the patient would justify the attempt In those cases in which the condition of the patient is grave and the viability of the bowel has been lost exteriorization of the gangrenous bowel with provision for enterostomy should be performed in the most expeditious manner In strangulated hernias the obstruction should be released and the contents of the sac thoroughly observed to determine the viability before the sac is returned to the abdomen Following the release of the obstruction repair of the hernia by the modified Bassini method should be performed

The mortality in complete mechanical obstruction as before stated is in direct proportion to the time intervening between the onset of the symptoms and the surgical intervention The degree of obstruction and the condition of the patient should dictate the operative procedure It should be kept in mind that prolonged and complicated procedures contribute materially to mortality in those cases in which temporary procedure of the simplest type may be the life saving factor

**Case Reports**

I A young man was adm tted for left ingu nal complete st angulat g hern a wh ch occurred at a camp s xty m les distant f om the hosp tal The pat ent had not ced a m ss n the left gro n fo seve al week a d had m de no p e ious report of h s condit on Onset of symptoms began fter a st a i g eff rt h le l fti g Colicky p ins nausea nd vom t g ensued nd v he effo ts of the pat ent fa led to rel eve the mas h report d fo treatment and was t ansfer ed to the h sp tal whe e mmediate urgery was decided up n Sp nal anesthes a was u ed and wh le th abdomen was bein dr ped the mass spontane usly r duced Th operation was proceeded w th and he the sac was op ned a co s derable amount of serosanguineous flu d w s encount red Investigat on was made of the former contents of the sac a d a 9 inch gangre ous sect on of the jejunum

was e cou tered As the pat ent was in good cond tion p imary resection was performed following wh ch the hern a was repaired Recovery was uneventful

II A wh te man a ed s xty years who as admitted for the treatment of arthr t developed sudden severe col cky pain nausea and omit g at 1 00 A M and made no eport for several hours When examined by the officer of the day clas cal signs of acute mechanical obstruction of the intestine w re apparent There was a m ld degree of shock Explorat on of the abdomen revealed v l ul s of the jejunum with 18 inches of devital ed intestine P mary resection was performed Convalescence was neventf l u t l the tenth day when he beg n to have nausea and to vomit Blood w s pos t v fo malar a Q ine th apy wa nst tuted with the abatement of all symptoms and the p tie t re overed promptly

Fg 352—D t d d l p f m ll b l d t l M ll Abb tt t b n case f b t t l I l D t sed h t be in pl Ope tı R y

III A m ag d twe ty e ye wa dm tt d t th h p t l M ch 1 1941 w th the d agn of b t u t f th il m d e t

adh s o s following operat on pe formed n 1929 prior to entry into military se v ce H s chief complaint v as abdominal pain and vomit of one d y s duration His history revealed that at the age of twelve he had an ope at on for appendicitis through a McBurney incis on Since that t me he has had repeated attacks of abdominal pain w th vomit g on an average of two to three times a year The present attack esembled the former o es e cept that it was con siderably more se ere The remaining history was not nonessential Physical e m nation revealed a moderately distended abdomen with no p rt cular tende ness Exam nat on of the heart and lun s was essentially negative A Mille Abbott tube w s passed unde fluoro copic visual at on (Fig 352) and a satisfacto y decompress on was ffected The tube re ched the po nt of obstruct on on the third day afte which t pas ed nto the cecum and down to the sigmoid colon Follow ng decomp ess on by this means an exploratory laparotomy was done on Ma ch 5 at wh ch time ther extens ve adhes ons angu lat g the ileum to the old sc r were fou d to be the cause of the bst ction These adhes ons were f eed and the patient subsequent po tope t ve course was uneventful He was returned to duty in the usual t me

## PEPTIC ULCER

The complications of peptic ulcer whether it be situated on the duodenum or on the stomach are the most serious and most dramatic of the acute abdominal emergencies

**Hemorrhage** —Bleedin of varying degree probably is the most frequent complication of peptic ulcer It may be a dif ficult problem to determine the source of a massive hemor rhage in an individual who is admitted to the hospital with no previou history of ulcer Occasionally the emergency arises in patients already in the hospital and under treatment for ulcer the incidence of the complication in duodenal ulcer being approximately 18 to 20 per cent

When a diagnosis of massive hemorrhage from ulcer has been determined the therapeutic procedure to be followed must be decided upon immediately While fatalities from the first hem orrhage do occur most patients survive it and the condition yield to medical management Patients with repeated small hemorrhages or recurrent massive hemorrhages should be sub jected to surgery at the optimum time It has been our policy to operate after the second hemorrhage

The operative attack upon the ulcer should be direct and should include some type of resection In patients whose condition i too serious to justify the time consumed in re ection favorable results have been obtained by the Devine type of pyloric exclusion the distal segment being split until the ulcer is exposed and then the vessel leading to its base are ligated Gastro enterostomy alone has no place in the treatment of hemorrhage from duodenal ulcer

**Acute Perforation**—Both in the case of a patient with known history of an ulcer and in the case of a patient who has had no previous indications of digestive distress the sudden onset of excru iating pain initial collapse and boardlike rigidity of the abdomen are almost classical manifestations of acute perforation a a complication of an ulcer Lest this condition be confused with an acute coronary episode electrocardiography and roentgenologic examination of the abdomen for free air beneath the d aphragm are advised as preoperati e diagno tic procedures

Treatment of thi cond tion is emergency in every sen e of the word The mortality is in direct proportion to the time that elapses between the pe foration and the operation and i exceedingly low if operation is carried out in the first six hours

It i usual in military ho pitals to receive a patient of this kind soon after the onset of symptom since medical diagnosis and transpo tation to a ho pital are immediately available The type of operation performed is simple closure of the perforation by mattress suture and the attachment of an omental ta to the suture line Drainage of peritoneal cavity is employed

Subsequent to recovery from an acute perforation an ul er regimen is maintained At a later d te fo those patients whose symptoms pe sist direct surgical attack n the ulcer by some type of part al resection is ad o ated

**Postoperative Care**—Int rmittent su tion by the Lev ne tube with a sy inge s employed since an ndwelling tube with continuous suction i con dered a hazard in an indu ated and friable ulcer bed which has been r pa r d Flu d balance is maintained by intravenous administ at on of gluco e 5 per

:ent and salıne Sulfathıazole or sulfanılamıde ıs used ın those :ases ın whıch perıtoneal soılın͏g ıs great

BIBLIOGRAPHY


. Blıss R ym d W Lt C l l M d l C p U S A my d H t L d D C pt M dıcal C p U S A m A l f S g y F b ry 1938

! J h L W C pt M d l C p U S N vy d B H R C mm d M d l C p U S N vy U t d St t N l M d l B ll t J y 1937

The operative attack upon the ulcer should be direct and should include some type of re ection In patients who e con dition is too erious to justify the time consumed in re ection favorable re ults have been obtained by the Devine type of pyloric exclusion the distal segment being plit until the ulcer i exposed and then the vessel leading to its base are ligated Gastro enterostomy alone has no place in the treatment of hemorrhage from duodenal ulcer

**Acute Perforation**—Both in the case of a patient with known history of an ulcer and in the case of a patient who has had no previous indications of di estive distress the ud den on et of excruciating pain initial collap e and boardlike rigid ty of the abdomen are almost classical manifestations of acute perforation as a complication of an ulcer Lest this condi tion be confu ed with an acute coronary epi ode electrocar diography and roentgenologic examination of the abdomen for free air beneath the diaphragm are advised as preoperative diagnostic pro edures

Treatment of this cond tion is emer ency in every sense of the word The mortality is in direct proportion to the time that elapses between the perfo ation and the operation and ex ceedingly low if operation is carried out in the first six hours

It i usual in m litary hospitals to recei e a patient of this kind oon after the onset of symptom since med cal diagnosis and t an portation to a hosp tal are mmediately available The type of operation performed i simple closu e of the perfora tion by mattress suture and the attachment of an omental ta to the suture l e Drainage of pe itoneal ca ity is employed

Subsequent to reco ery fr m an acute perforat on an ulcer regimen is maintained At a later date fo those patients whose symptoms pers t direct su gical atta k on the ulcer by some type of partial re ection is ad ocated

**Postoperative Care**—Inte mitte t suction by the Lev ne tube with a syr n e s employed s nce an indwell ng tube with continuous suction i consid red a haza d in an indurated and friable ulcer bed which ha been repaired Flu d balance is maintained by i t a enous admin stration of glu ose 5 pe

# TREATMENT OF CRANIAL INJURIES IN WAR

FRANCIS C GRANT M D F A C S

P ES N S H MED CIN UNIVE IT PE YL AN

---

THE present day treatment of war wounds of the head depends upon many factors General surgical principles for their treatment were established during the final year of the war of 1914–1918 but new developments especially with regard to antisepsis and anesthesia have appeared which may modify these principles Two lessons from World War I seem to stand out with regard to head wounds first that in cases of cranial trauma the patients can be transported with greater safety *before operation* than immediately thereafter and second the results in operative treatment of these cases are better when *specially trained men in properly equipped centers* handle them than when such cases are assigned to the general surgeon

## REQUIREMENTS OF A NEUROSURGICAL CENTER

The staffing and equipment of the neurosurgical centers will determine the success or failure of the surgery performed Adequate electric power is the first essential For one thing it is necessary for the operation of roentgen ray apparatus Again the two important technical advances in neurosurgery in recent years namely the introduction of suction and electrosurgery depend upon it An electromagnet for the removal of deep seated steel fragments from the brain proved its value in 1917–1918 Heller states that the Germans have established special centers equipped with giant magnets to remove fragments from brain or eye The power plant is therefore vital and should be of sufficient size to handle easily all such station requirements

the more extensively the brain has been injured and the more widely the cerebrospinal fluid spaces have been opened the higher the death rate Certainly the treatment of injuries of types III to VIII (there is little treatment available for class IX) is fundamentally the same in its general principles The degree to which the underlying brain is damaged the difficulties attending the debridement of the brain wounds and the removal of foreign material the time interval elapsing between injury and operation and the amount of infection already present are the factors that will determine how such wounds should be handled

## MANAGEMENT OF CRANIAL INJURIES IN WORLD WAR I

In his capacity as senior consulting neurosurgeon to the American Expeditionary Forces in 1918 Dr Cushing issued suggestions to the neurosurgical teams which demand repetition Every scalp wound no matter how trifling is a potential penetrating wound of the skull Many penetrating wounds are met with even among the walking wounded Only after an x ray after shaving the head and possibly only after exploration can one be assured that there is or is not a cranial fracture with or without dural penetration

If a case is operated upon and a penetration found the operation must be completed with a primary closure following the special debridement applicable to these injuries In this respect wounds of the nervous system differ from other wound which in times of rush should not be subjected to primary wound closure All or nothing is a good rule to apply to cranio cerebral injuries—in short evacuate these cases untreated to the nearest base (except for shaving and the application of a wet antiseptic dressing) rather than do incomplete operations Patients with cranio cerebral injuries stand transportation well before operation badly during the first few days after operation This is true of all primary wound closures

Cranial cases in more or less shock (on arrival at the base) need not undergo a period of resuscitation The operation should be done under local anesthesia combined with morphine

Cutler has stated recently that the efficiency of any hospital depend largely upon the following factors adequate electric power proper sterilizers and a good laundry It is to be hoped that in the rush for planes tanks ships and guns our Army Medical Corps will see to it that their basic needs are supplied The Royal Army Medical Corps developed and sent to France an adequately equipped mobile neurosurgical unit. The plans together with any improvements shown necessary under service conditions should be available Some similar arrangements will be essential if head wounds are to receive adequate treatment

## CLASSIFICATION OF HEAD WOUNDS

After the last war the United States Medical Corps publications divided head injuries into nine groups upon the basis of their severity as gauged by the mortality rates

| | | Mortality Per Cent |
|---|---|---|
| I | W u d of the scalp | b ut |
| II | C an al fractu e v tho t d l p etrat o | ab t 10 |
| III | C n l f ctu e w th d press o a d dural pene t t but w th ut t s n f b | abo t 20 |
| IV | W u ds ( ually f gutt r typ ) w th b n tr d d ind e fra m ts f b ne | ab ut 30 |
| V | Wo nd u ually f p n t at ng typ w th d b f m ts pl s metal | bout 40 |
| VI | W nds of typ IV nd V th p t at on f bo e o met l pe l al entr cl s | about 50 |
| VII | C fa l w u d wh ch th eth n d l p t sal inus re p n d m k pr m y l s mp ble d t th k f c d y inf t | ab ut 60 |
| VIII | P f r ti g t w nd | ab t 0 |
| IX | E t b t g f t | lm t lw y fatal |

Th clas fication of head jur es s all n lu e and seems somewhat cumbersome In any cranial nju y the outcome depend in great part upo two facto s fir t the degree to which the bra n tself has be n dama d and seco d whether or not the dura has been opened As the f gu es n the table indicate

may shift many miles in a week The U S Army Medical Corps is prepared to meet the old conditions It is essential that every effort be made to adapt the organization to as ure prompt and effective tran portation of wounded under the de mands of a rapidly chan in battle front *Mobile units* that are staffed and equipped to handle specific types of wound such as those of the head and thorax and that move with the fighting lines may well be an answer to thi problem Perma nent hospitals may be too far to the rear to make transporta tion easy

Ducuing in a paper based on his experiences in the Span ish Civil War ives a vivid description of the head wounds h encountered The scalp wound are never clean cut the skin being usually widely contused in more than one area The frac ture is alway comminuted with fissures extending toward the vault or base The inner table is always more severely damaged than the outer with large fragments detached from it even though the outer table may not seem to be badly frac tured The dura i torn and contu ed The brain substance beneath the injury or along the perforating tract i reduced to a pulp in which are often lod ed hair bone fragments clothing or shell splinters The ventricles have frequently been pene rated The wounds are often of the throu h and through type and are associated with more destruction of bone at the point of exit than at the point of entrance The wounds are frequently multiple especially from machine gun bursts are always septic and are not infrequently accompanied by addi tional wounds of extremities thorax or abdomen

## TREATMENT OF HEAD WOUNDS AT THE REGIMENTAL FIRST AID STATION THE DIVISIONAL CLEARING STATION AND THE BASE HOSPITAL

When such wound are seen at the *regimental fi st a d sta tion* nothin should be done except to shave the head about the wound paint the skin with an anti eptic and apply a ster ile dressin No attempt whatever should be made to clean the wound itself A *field ca d* should be made out for the patient It hould tate the type and location of hi wound and its

Consequently the patient can be properly warmed and given fluids during the course of the operation through which he will often sleep Only in exceptional cases when the patients are irrational or uncooperative i a general anesthetic necessary Its administration always adds to the difficulty of the operation and by increasing intracranial pressure causes extru ion of brain and tend to increa e the damage already done

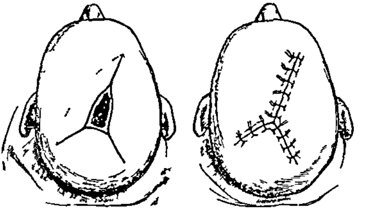
The chief source of the high mortality in cranial wounds is infection—i fection of the menin es direct infection of the brain leading to encephaliti infection of the ventricles Wound in which the dura has been penetrated are supposed to give a mortality of 50 to 60 per cent due to infection It however has been shown that experienced neurolo ical surgeons can lower this supposedly inevitable mortality to 25 per cent if the operation can be done with reasonable promptitude in a forward area and the cases retained for a reasonable time after operation These figures are capable of still further improvement

## PRESENT DAY PROBLEMS IN MANAGEMENT

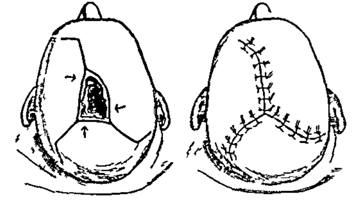
The wound of this war will differ but l ttle from tho e een in 1914–1918 Cairns and Wo eler have noted a tendency for them to be produced by smaller metallic fragments than formerly The explosives now used are of greater bursting power and throw off less bulky spl nters at a higher velocity Multiple wound are more frequent (Broster ) But the principles of treatment are the same now as they were in the first World War It i true that it is better to admini ter tetanus toxoid than antitetanus serum after njury and that there ha been an mpro ement in the era to p event ga bacillus infection The development of the sulfa derivat ve open up tremendou possibil t es in the prevention of inf ction

In the last analysi however the p oblem i still the same namely proper organization needed to a su e apid evacuation of the wounded to effect vely staffed and equ pped hospitals The problem seems vastly d ffe ent now than in 1918 when the fi htin fronts wer fi ed fo long per od now they

reliance upon the efficacy of the drug seemed to be the chief trouble The close application of the powder to all parts of



F 353—T p d f m ll gul w d f th lt ( ft C h g) Th d tt d l n d at f fl t f fl p (F m M d D pt U S A my W ld W 1927 Vol XI S g y pt 1 p 786)



Fg 354—Th l g d (I l f M ) f t g ds f ial lt (C h g) (F m M d D pt U S A my W ld W 1927 V l XI S g ry pt 1 p 786)

the wound i difficult The e men suggest the incorporation of the ulfanilamide in a va eline base so that it can be u ed in

cause (machine gun bullet bomb plinter etc) A brief description of the patient s condition together with instructions for hi evacuation in a sitting or in a recumbent position should al o be given

When the patients reach the *di isional casualty clearin station* the dressings are revised At this point the examination of the wounded is more detailed and an attempt is made to reach a definite opinion as to their proper dispo ition Patients with obviously hopeless injuries are retained and given morphine if they are not uncon cious Those with rapid and irregular pulse with bilateral complete pupillary relaxation with loss of phincter control or pasticity of all four extremities do not warrant evacuation All wounded should be given anti gas bacillus serum injections and 2 to 4 gm of sulfanilamide by mouth or under the skin Rapid evacuation i indicated for cases with evidence of extradural bleeding The field cards of the wounded should state the urgency of their condition and whether there s a need for immediate operation Patients with gutter wounds ith penetrating wound whether partial or complete or w th multiple injurie should be tran ported later They should always be lying down when moved from place to place

The questio of the admi istration of blood or other *st mu l nts* to these patients equires n ce jud ment General experience seems to indicate that such measures may increase intracranial bleeding Hypertonic olut ons such as 50 per cent gluco e or 10 per cent aline eem of more value than blood or stimulant s they have a dehydrating action o the brain and help a ell t rel ve ho k

Should *lfa l de* be u ed *lo ll* in w und whe the d es ng are r ie l at the d c al t tion Mitchell Logue a d Ha dley reached the conclu i n ba ed o thei perience in the Briti h c pa g n i L bya that mu h had till to be learned about the local ppli ati n of ulf nilam de to make it really effective The l beral u e of th d u loc lly certainly d d not neutr l e neglect of th c rd nal po nts the treatment of war ound In uff i nt l a age d e to a too g eat

erative difficulties An intratracheal tube insures a free airway and in desperate cases permits the better administration of oxy en As Cushing describes patients in shock can be revived by heat and fluid given intravenously during the operative procedure and the proper sulfa derivative given at the same time

The scalp is thoroughly cleansed and the wound examined Debridement of the skin edges is done and the knife and for ceps discarded Enlargement of the skin wound is best accom plished by the tripod incision or if more room is needed by the Isle of Man inci ion (Figs 353 and 354) The fracture is not treated by removing with a rongeur the dirty edges of the wound until a clean area is reached instead trephines are placed just lateral to the edges of the wound a space is cut between the trephines with Montenove i or De Vilbiss forceps or a Gigli saw and then the fractured portion is lifted out in one block (Fig 355) The dura is now inspected It should not be opened unless a definite indication exists If the membrane is tense and purple obviously overlying a blood clot or con tused brain it should be inci ed the underlying blood and con tused brain sucked out and then the dura carefully closed with interrupted sutures of fine silk on small round needles without cuttin edges The galea and skin are now tightly closed with interrupted silk sutures without draina e or at most a rubber drain i placed in a dependent angle of the wound

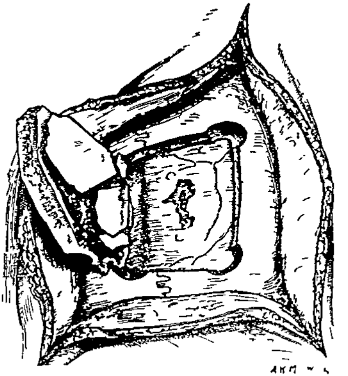
## THE TREATMENT OF PENETRATING WOUNDS OF THE BRAIN

As can be seen by reference to the classification giving the types of head injuries a penetrating injury can be of any variety Once the dura has been pierced and fragments of bone or metal have entered the brain the general principles of treatment are the same regardless of the size and depth of the wound

**Conservative versus Radical Methods** —Cairns recently has stated Brain ti sue re i ts and localizes bacterial infec tion as well as if not better than other tis ues it is the ven

the way in which bismuth iodoform paraffin paste (bipp) was employed in the last war They recommend highly its immediate and continued administration by mouth

On arrival at the *base hospital* the wounded are reexamined and the urgent cases are selected for operation In the last war



Fg 3 —I di th m f m th mp d mm ted f gm f b (F m M d D p t S A m W ld W 19 7 V I XI S ry pt 1 p 8 )

local ane thesia ether a d chl roform v e the esthet cs available Local anesth a e nf ed with mo ph ne is best but avert n and pentothal s d um a lt r at es Pulmonary anesthesia should not be u ed f it ca be a o d d s nce it te d to raise nt acran al pre u e and th s nc ease the op

erative difficulties An intratracheal tube insures a free airway and in desperate cases permits the better administration of oxygen As Cushing describes patients in shock can be revived by heat and fluids given intravenou ly during the operative procedure and the proper sulfa derivative given at the same time

The scalp i thorou hly cleansed and the wound examined Debridement of the skin edges is done and the knife and for ceps discarded Enlargement of the skin wound is best accom plished by the tripod incision or if more room is needed by the Isle of Man inci ion (Figs 353 and 354) The fracture is not treated by removing with a rongeur the dirty ed es of the wound until a clean area is reached instead trephines are placed just lateral to the edges of the wound a pace is cut between the trephines with Montenovesi or De Vilbiss forceps or a Gigli saw and then the fractured portion is lifted out in one block (Fig 355) The dura is now inspected It should not be opened unless a definite indication exists If the membrane is tense and purple obviously overlying a blood clot or con tused brain it should be incised the underlying blood and con tused brain sucked out and then the dura carefully closed with interrupted sutures of fine silk on small round needles without cutting ed es The galea and skin are now tightly closed with interrupted silk sutures without drainage or at most a rubber drain is placed in a dependent angle of the wound

## THE TREATMENT OF PENETRATING WOUNDS OF THE BRAIN

As can be seen by reference to the classification giving the types of head injuries a penetrating injury can be of any variety Once the dura has been pierced and fragments of bone or metal have entered the brain the general principles of treatment are the same regardle s of the size and depth of the wound

**Conservative versus Radical Methods** —Cairns recently has stated Brain t sue re ists and localizes bacterial infec tion as well a if not better than other tissues it is the ven

tricular cavities and large basal ci terns that are so vulnerab e to the spread of infection In brain wounds as in wounds of the limb it i desirable to remove necrotic tissue bone splin ters and foreign bodies with the object of preventin or re trictin the spread of infection in the form of purulent en cephaliti absce s purulent ventriculitis and menin tis The aim is to obtain a clean smooth walled cavity which with the aid of light packing will heal by granulation Thi is the ideal but there are weighty limiting factors The operation mu t be done without encroaching on important nervous pathways that are known to be intact and without opening the entricular cavities or basal ci terns Preparations for treatment there fore include thorough clinical examination and radiographi urvey of the foreign bodies Mi siles deep in the brain hould usually be left alone and superficial wound over such impor tant areas as the pre and post-central gyri should be interfered with as little as po sible

How i the balance to be struck bet een conservative meth od so es ential in ome ca es and the bold operation o neces sary in other ca es if fatal infection is to be prevented Inadequacy of surgical facilitie will in some instances decide the question for the time being but in most doubtful cases the only su e guide to treatment is the clinical state of the patient observed from day to day In a patient with a deep penetrat ing wound of the brain with small perture intervention may at time be postponed until the physical s ns or increa e of protein in the cerebrospinal flu d i d cate that the bra n le ion i extending in tead of h aling In large open wound of the brain the remo al of nec otic ti sue easy f suction apparatus is available This pparatus es ent al in all brain operations After careful hemostasis the wound is l ghtly packed and the cond tion of the re ult ng b a n fungu is subseque tly con trolled by lumbar punctu es at frequent interval

**Exposure and Cleansing of Wound**—The general prin ciples to be ob erved in the t eatm nt of these wounds of the brain a e as f llo An adeq ate sk open n c ntered on the surface wound m de by an Isle f M n ncis on The

skin edges of the penetrating wound should be carefully excised The fragmented portion of the skull is removed by trephining and cutting around it then it is lifted out in one piece If the wound is of the gutter type near the sinus a spicule of bone may have been driven into the sinus Its removal will be followed by furious bleeding Such hemorrhage is best treated with a stamp graft of muscle held over the bleeding point by the finger for a minute or two and when the bleeding is checked maintained in po ition by a suture

The opening in the dura should not be enlarged nor the adhesions between it and the underlying brain broken up but all fragments of dura must be excised The patient is now asked to cough or strain or if he is under an anesthetic the anestheti t increases the intracranial pressure by jugular compression in the neck thus forcing out clots and other debris Further cleansing of the wound is accomplished by irrigation with saline solution and finally the tract is carefully cleared of all contused brain with the suction apparatus until a smooth walled cavity has replaced the ragged tract All foreign bodies are of course searched for and removed unless they are small and very deeply indriven Especially if metallic such fragments are best left alone

**Closure of Dura and Skin** —The problem now comes up as to the closure of the dura and the skin Cushing who worked in a casualty clearing station near the front where the patients were seen usually within forty eight hours after being wounded gives it as his opinion that skin closure without drainage is indicated whenever possible Horrax [1] who worked farther behind the lines in a Base Hospital where the wounded were seen from four to six days after injury with consequently much more widespread infection expressed the belief that the skin should not be closed He prefers to leave the skin flaps open to obtain better drainage accept fungus formation as a favorable complication and control its formation by repeated lumbar tap But as a rule primary closure of galea and skin in separate layers with interrupted silk sutures is indicated

It is in this group of ca es certainly that the *sulfa-dem*

*ati es* may revolutionize method and results Fal oner and Ru sell[1] and Manifold have shown that sulfathiazole in i o-tonic and approximately neutral solution i relatively harmle to the brain Certainly these solution by mouth or ubcutane ous admini tration hould be able to control meningitic infec tion and in many ca e make it pos ible for the surgeon to close a much higher percentage of wound with healin by fir t intention without sub equent development of a brain ab ce or encephalitis

**Osteoplastic Flap Technic**—Burckhardt Vincent and Lafon and Garcin and Guillaume have u ed the formal o teoplastic flap in the sur ical approach to penetratin wound As they state this u age i only po sible in advanced zone neuro urgical ho pital well tafted and with complete neuro-surg cal equipment An osteopla tic flap is turned down around the penetrating wound Ducuin states that he attempted the technic but found that the fractures around mo t penetratin wound were o exten ive that the flap broke to pieces when it was being elevated Vincent sutures the dura to the brain about the defect to produce adhesion a d to wall off the sub-arachno d pace Careful debridement of the tract now i in tituted and finally the t act completely exci ed with fine ci ors The dural defect clo ed ith a fa cial graft or with amniotic memb ane the flap replaced the galea and skin care fully utured Garcin and Guillaume pecially emphasi e the value of the sulfonamide derivative postoperatively

This techn c is c tainly the ideal toward which the neuro-sur eon should aim With advanced mobile team to whom the wounded can be sent ith n ten to twelve hour plus an oppor tun ty to keep them unde b e vat on fo the three weeks fol lowing operation many pr blem may b sol ed But when the paper of Ducuin is re ew d and compared with the others mentio ied a d tinct mp ession gained that the condition he describe are mo e nearly the t ue p ctu e In the presence of a penetratin cranial wou d that pr ent at least poten tial evere infection to tu n do vn a flap and t clo e the dura ti htly eems l ke fl in d ectly n th fa e f P o idence

**After care**—Following operation patients suffering from head injuries should not be evacuated for a minimum of three weeks A nursing personnel familiar with the after care of such types of wound should be detailed to the neurosurgical hospitals

The most dreaded *postoperative complications* are hemorrhage brain edema and above all infection The evidences of the development of such complications are often masked at their onset and experience is needed to interpret them Unfortunately when they become full blown for any tyro to recognize it is too late to do much to combat them effectively

Postoperatively free sedation is to be preferred to strap restraint in restle patients Straining against handcuffs increases intracranial pre sure and encourages hemorrha e and intracranial edema Pressure can be relieved by lumbar or ventricular taps Fluids should be administered freely with blood or plasma as needed The operating surgeon should if circumstances permit see to the after care of the wound of hi own patients He knows exactly what was done and has therefore the best idea of what complications to expect Furthermore although the neurosurgeon has learned much about what he can or cannot do in brain injuries in the last fifteen years and although he has the sulfa compound to help him combat infection he will find that war surgery pre ents new and perhaps diff cult experiences Mistakes will of course be made but the men who see their patients most frequently will profit most quickly from their errors

## BIBLIOGRAPHY

1 H ll E C th R m l f F g B d f m th B by th U f M g t d th F m t f H p t l C t g G t M g t D Ch g 11 705 (O t 15) 19 9
2 C tl E C D W C l A S g 6 103 (J ) 1941
3 I l d M j G M W Th M d l D p tm t f th U S A my Th W ld W V l XI S g y P t I G l S g ry O th ped S g y N g y W h t 1927
4 C m H T tm f H d I j W B t M J 1 10 9 (J ) 1 10

5 \ g l K M g m t P g d L t R lt G -sh t W ds f Sk ll Med W lt 14 1085 (Oct 26) 1940 14 1113 (N ) 1940
6 B t L R S gl l P bl m f th W A S g 113 891 (J ) 1941
7 D g J DH rt J G in A d F l h A G ral Prin ples th T tm t f C b l W d W R d Chr 77 6 5 (N De ) 1939
8 M t h ll G A G L gi N J d H dl y R S Cas l es f th W t D sert t I by L t 1 713 (J 7) 1941
9 C h g H A St d f Se es f W u ds I t th B ai d I F l p St t re B t J S g 5 558 (M y) 1918
10 H C Obse t S f G sh t W ds f th H d B t J S g 7 10 (J ly) 1919
11 F l M d R ell D S Eff t f A t ept cs W ds Brit M J 1 631 1940 P R y l S M d ( p )
12 M f ld M C Eff t f A t sept W ds B M J 1 6 l 1940
13 B kh dt H F ed h M th d f W d E d C t m ry Par t l W d E P t l l i C l d C b l I j ries D ts h Ztsch f Ch 254 249-261 1940
14 \ t C d Laf J L N cal T tm t f Cra oce bral I j J d M d t Ch P t III 87 Ap l 10- 5 1940
15 G R d G ll m J N th T tm t f H d W unds W d th R lts Obt d b th Use f M d N ros rotcal M h d Ad d Z H p t l M m A d d Ch 66 124-136 (J 31 F b 7) 1940

# MILITARY UROLOGICAL SURGERY

VIRGIL H CARSON MD FACS

CAPTAIN M C C U ITED S ES N E ECU n OFF CER U IT
S N AL H IT B OO N Y K

AND

CHARLES Y BIDGOOD MD FACS

LIE TE A C IA ER MED C U S N AL RESER E
N AL MED AL CE W TO DC

---

THIS article is not intended to be a treatise on the entire field of urological surgery but is submitted with the idea of acquainting Medical Reserve Officers particularly those on active duty and those expecting to be called to active service in the near future with some of the surgical urological problems presented by the Navy

## DEVELOPMENT OF UROLOGICAL SURGERY IN THE NAVY

Urological surgery in the Navy is similar to the same type of surgery performed in civilian hospitals and clinics throughout the country It might be interesting at thi point to review briefly the development of urology in the Navy Prior to the year 1920 the Department of Urology as it is now designated was called the Genito Urinary Department Cases admitted to this service were largely venereal in nature and consisted principally of syphili gonococcic infections chancroidal infections and various complications of these diseases Skin diseases were also treated in this department The amount of cystoscopic work performed prior to 1920 was very limited due to the facts that the departments were not adequately equipped and

Th p se t t ed h th pri t es f th
nt rs d re t t be ru d ffi l fl t g th f th
N y Dep rtm t th N l Se ce t l g

that there was a lack of trained urological surgeons Urological patients who were admitted to the department were later transferred to the Surgical Service for operative treatment

**Training and Clinical Experience of Personnel**—In 1921 the Bureau of Medicine and Surgery instituted a system of training its medical officers by giving them special courses of instruction in urology in some of the larger clinics in the country namely The Brady Urological Institute Baltimore Maryland The University of California San Francisco California The Brady Urological Institute New York City and the Post Graduate Medical School and Hospital New York City As a result in the past twenty years a sufficient number of Naval medical officers have completed these courses to staff the Urological Departments in our hospitals

The admission of Veterans Bureau patients to Naval hospitals was commenced in 1921 and these patients have probably contributed 80 to 85 per cent of surgical urology during this period of twenty years For example in the Naval Hospital at Philadelphia out of a total of 800 patients approximately 500 are Veterans Bureau patients the majority of whom are in an age group in which a high percentage of surgical urology is to be expected

The above two facts namely the special training of Naval medical officers in civil an clinics and the vast amount of clinical material supplied by the Veterans Bureau have been largely responsible for the development of urological work in the Service

**Present-day Organization**—The Department of Urology is conducted as a separate department in most of our larger Naval hospitals with its Chief of Service who is responsible for his own surgery Its organization is patterned after the general scheme of a civil institution In some Naval hospitals the Urological Department is included under the general Surgical Service with the Eye Ear Nose and Throat Physical Therapy and $x$ Ray Departments for administrative purposes only The Urological Department also includes Syphilology and until very recently it also included diseases of the skin

*Advantages in Shifting Syphilis to Department of Dermatology*—In one of our larger Naval hospitals syphilology and dermatology have just been placed in a combined Department of Dermatology and Syphilology This arrangement appears particularly advantageous at this time and for the following reasons

1 Cutaneous diseases represent a fairly large proportion of the total morbidity and until now have not received their merited specialistic attention

2 Syphilis is combined with Dermatology in civilian practice and civilian institutions and all qualified dermatologists are also qualified syphilologists At the present time the calling in of significant numbers of Reserve physicians insures the Medical Corps of adequate numbers of dermatosyphilologists while the urologists being called to active duty are not trained or experienced in syphilology

3 The placing of syphilis in the Department of Dermatology puts it in a medical specialty and removes it from what is primarily a surgical service It is universally acknowledged that the problems of syphilology encompass many aspects of general medicine

4 Both the urologist and the dermatosyphilologist will be able to work with greater efficiency and the services to function at a higher degree of perfection in specialized treatment instruction and training when the lines demarcating the specialties within the military establishments are equivalent to those now generally accepted in all nonmilitary medical activities

*Staff and Equipment of Hospitals*—Two urologists are assigned to our larger Naval hospitals provided the exigencies of the Service permit The actual ward space assigned to urological surgery is usually approximately equal to that provided for syphilology and venereology A completely equipped cystoscopic room is maintained and usually located in the immediate vicinity of the x ray department Two standard cystoscopic tables are provided with the necessary x ray accessories The supply table of the Medical Department U S

Navy lists a complete line of basic supplies and equipment which are available on requisition Special items of equipment are available on approved special purchase requisitions and by placing such items on the advance budget

## KIDNEY

**Acute Infection** —ETIOLOGY AND PATHOLOGY —Almo t all acute renal infections are blood borne and etiologically may be divided into two groups *bacillary* and *coccal* infections The predominating bacillary infections are those organi ms constituting the colon typhoid group According to one theory these organisms attack that portion of the renal parenchyma distal to the glomerulus hence drainage into the kidney pelvi is good therefore the infections usually sub ide under con servative treatment and never result in parenchymal abscess carbuncle or perinephritic extravasation of pus The cocci are prone to attack the kidney as arterial emboli hence lackin drainage they give ri e to multiple cortical abscesses car buncle and if they rupture through the capsule perirenal extravasation of pus

There are two type of kidney infections which deserve es pecial consideration *Bacilli s p otei s* and tuberculosis The proteus bacillus cau es a clinical p cture no more virulent than that cau ed by the more common bacilli but because of its power to plit urea and alkalinize the urine it is a prime pre cursor of stone formation This organi m i the frequent in vader in cases of avitamino is the sequence of events being avitamino i alkalinization of the ur ne B proteus infection and stone formation It is impossible to acidify the urine from a kidney so infected and Higgins ha demon trated that al though the bladder urine may be made ac d th an acid ash diet and acidifying agents the urine from th kidney with the proteus infect on will remain lkaline

Renal *tuberculosis* is a condition famil ar to everyone Suf fice it to ay that the pathological pictu e var es from that of acute diffuse pyelonephrit s at the o set to abscess formation or pyonephrosi or if the healing pro e s predominates to

tubercle formation cicatrization and sometimes complete heal ing That this latter can occur is questioned by many

Diagnosis —The clinical picture of acute urinary infection is that of general sepsis with fever leukocytosis local pain tenderness rigidity and usually pyuria and bacteriuria In the bacillary infections the last two findings are constantly present and in the coccus infections about 50 per cent of the time in the early stages of the infection The theoretical reason for the absence of bacteriuria in coccus infections has already been noted

Treatment —The management during the acute stage i conservative and includes rest forced fluids and the judicious use of sulfathiazole Blood nonprotein nitrogen determination should be made since if the infection is bilateral this may be come elevated Determination of the causative organism is of utmost importance for the reasons explained above concern ing the difference in the pathological changes in bacillary and coccus infections If the offending organism is one of the colon typhoid group it may reasonably be expected that in a few days the infection will subside and in time either become chronic or disappear entirely

With the cocci however the possibility of *abscess* must be borne constantly in mind and if the picture of sepsis does not disappear daily careful abdominal examination should be done in order to elicit increased local tendernes muscle spasm and above all a mass Also continuous or ri ing leukocytosis is evidence of a nondraining accumulation of pus Intravenou pyelograms are helpful to demonstrate distortion and displace ment of the renal pelvis due to abscess formation

If the clinical picture improves to the point of complete sub sidence then *cystoscopy* is indicated to determine the presence of any pathological changes mainly obstructive in character which would prevent complete sterilization of the urine If none are found but the urine does not become sterile *chemotherapy* is indicated checked periodically by cultures of the urine No patient can be considered cured until the urine is sterile be cause normal urine is sterile Therefore as long as the urine

contain bacteria it cannot be considered normal and the pa tient i a candidate for an exacerbation

*Instrumentation* in the acute phase of renal infections should be avoided because of the danger of its causin septicemia It is indicated only when it is felt that information obtainable only by this is indi pensable in the further treatment of the condition *Intra enous pyelograms* should usually be made first but it often happen that an acutely infected kidney is at least temporarily nonfunctioning so that no concentration of the dye i obtained on the side where it i most desired

Recently the advances made in chemotherapy of renal in fections have been of great importance The most beneficial of the e have been in the u e of mandelic acid and the sul fonamide derivative *Mandelic acid* i especially efficacious in the colon typhoid infections and is g ven in the form of the ammonium or calc um salt 15 gm four times a day It is effica ciou only when the $pH$ of the urine i less than 5 5 therefore some limitation of fluid intake (usually to 1000–1500 cc daily) i necessary in conjunction with an acid ash diet and the ad ministration of some acidifyin drug such as ammonium chlo r de 0 5 to 2 g i da ly This regimen to ether with the fact that mandel c ac d is somew hat irritatin to the kidneys pre cludes its use n the acute infections whe e irritation is to be avoided and fl d are dicated t combat sepsi It find its greatest f eld of usefulnes in ch onic infections and should be given for not over ten days cont nuously

The *sulfonamide der vat v s* especially sulfathiazole are often spectacular n their action part cularly in coccus i fec tions However there are i d idual who seem to be ensitive to these dru s a d who ha e a eact on varying from mild nausea to seve e gastro ntesti al ups ts Others have kin re actions varying f om sli ht itchin to e fol ati e dermatiti so that in every ase in wh ch the dru is g en the patient should be e am ned daily and det rmi at ons of the red cell and hemoglobin content should be m d at f equent nterval

Irre pecti e of how beneficial the abo d u s have proved to be there will be e countered i fe t n wh ch ill re pond

to neither of them Therefore it is well to bear in mind that a great many renal infections were cured by forcing *fluids* and *pelvic lavages* before these drugs were discovered and it may be that the future will prove that these older remedies still have a place in combating some renal infections Neoarsphenamine intravenously 0 3 gm daily for six doses has occasionally proved beneficial in coccal infections

SURGICAL COMPLICATIONS —The surgical complications of renal infection are those which are encountered early in the course of the disease and those which arise after the acute condition has passed The former are those complicating the coccal infections *parenchymal abscess perinephritic abscess* as well as acute surgical conditions which develop as such because of pre-existing renal disease Surgical kidneys which develop as the result of prolonged chronic infection are almost invariably caused by obstruction due to *strictures* or *foreign bodies* such a stones which are the result of the infection rather than antedating it

One of the most difficult of urologic diagnoses is to deter mine when an infected kidney has passed from the stage of acute diffuse pyelonephritis (nonsurgical) to that of *carbuncle* or *perirenal extravasation of pus* (surgical) The reason for this difficulty is that the systemic reaction in the former with a virulent organism may be as severe as it is in the latter with a relatively le s virulent one Therefore the septic state is no criterion The result is that the urolo ist is usually in a dilemma and waits until sufficient time has passed to allow a nonsurgical condition to subside When this does not happen exploratory operation i decided upon

*Operation* —The operative procedure is to expose the kidney throu h the loin When Gerota s fascia is opened induration serum and even pus may be encountered The first two indi cate a mild perirenal reaction If free pus is found the tempta tion to drain it and terminate the operation is great but the surgeon must realize that th s pus is only that which has rup tured throu h the capsule of the kidney and that the important accumulation i beneath the kidney capsule therefore it is

contain bacteria it cannot be considered normal and the patient is a candidate for an exacerbation

*Instrumentation* in the acute phase of renal infections should be avoided because of the danger of its causing septicemia It is indicated only when it is felt that information obtainable only by this is indispensable in the further treatment of the condition *Intravenous pyelograms* should usually be made first but it often happens that an acutely infected kidney is at least temporarily nonfunctioning so that no concentration of the dye is obtained on the side where it is most desired

Recently the advances made in chemotherapy of renal infections have been of great importance The most beneficial of these have been in the use of mandelic acid and the sulfonamide derivatives *Mandelic acid* is especially efficacious in the colon typhoid infections and is given in the form of the ammonium or calcium salt 15 gm four times a day It is efficacious only when the $pH$ of the urine is less than 5 5 therefore some limitation of fluid intake (usually to 1000–1500 cc daily) is necessary in conjunction with an acid ash diet and the administration of some acidifying drug such as ammonium chloride 0 5 to 2 gm daily The regimen together with the fact that mandelic acid is somewhat irritating to the kidneys precludes its use in the acute infections where irritation is to be avoided and fluids are indicated to combat sepsis It finds its greatest field of usefulness in chronic infections and should be given for not over ten days continuously

The *sulfonamide derivatives* especially sulfathiazole are often spectacular in their action particularly in coccus infections However there are individuals who seem to be sensitive to these drugs and who have a reaction varying from mild nausea to severe gastro intestinal upsets Others have skin reactions varying from slight itching to exfoliative dermatitis so that in every case in which the drug is given the patient should be examined daily and determinations of the red cell and hemoglobin content should be made at frequent intervals

Irrespective of how beneficial the above drugs have proved to be there will be encountered infections which will respond

rather extensive preparation is that if a sudden profuse hemorrhage occurs one is prepared to open the wound quickly and stop it before the patient bleeds to death If such a hemorrhage occurs in the bed the patient may die before he can be taken to the operating room anesthetized and the wound opened The removal of the rubber dam can be accomplished with much less danger of bleeding

**Perinephritic Abscess**—There are many avenues by which infection may occur in the perirenal fat and enclosed within Gerota s fascia such as rupture of a cortical abscess of the kidney infection of a perirenal hematoma rupture of a pyonephrosis extension of infection from a retrocecal appendix and from the female adnexa all of which invade the renal fossa because of the anatomy of the fascial planes It is true that perirenal accumulation of pus results and on this basis the term perinephritic abscess is applicable but we believe that the term extravasation of pus is more appropriate because it is incidental to some other local infection and that the name perinephritic abscess should be used only to denote the clinical entity to be described below

Etiology and Pathology—Perinephritic abscess in the sense that we mean i the formation of an abscess around the kidney in which the etiologic agent *always* a coccus usually the staphylococcus sometimes a streptococcu invades the perirenal fat and an abscess results without pre existing disease in the kidney on the affected side This may seem to be a distinction without great difference but there is great difference from a surgical standpoint In the discussion of renal abscess and carbuncle it was stressed that if pus is found in the perirenal fat incision and drainag of the renal fossa do not suffice The kidney should be exposed and examined because the chief pathological change exists in the kidney and must be corrected Thi of course increases the danger of the operation With true perinephritic abscess incision and drainage are all that i required

Perinephritic abscess as a clinical entity i a condition in which metastatic infection in the perirenal fat occurs secondary

necessary to expose the kidney in order to determine the exact pathological condition existing there One of three conditions may be expected a single large abscess carbuncle of the kidney or multiple diffuse cortical abscesses

If a *solitary abscess* is present incision and drainage will suffice if not more than one third of the kidney has been destroyed If it has nephrectomy is indicated

If *carbuncle* is present several procedures may be possible If one pole is involved heminephrectomy may be done If the carbuncle is in the midportion of the kidney debridement with tamponade is possible If multiple diffuse abscesses are present nephrectomy is the procedure of choice

*Technical Points in Resection and Débridement* —The technics of resection and debridement deserve mention One is operating in the presence of acute inflammation and acute vascular engorgement which results in considerable bleeding unless special methods are taken to combat it This is done by compressing the pedicle lightly with a rubber shod intestinal clamp or by a soft catheter placed around it and tightened just enough to close off the renal artery during the operation Also this lessens the chance of squeezing any infection into the blood stream in the handling of the kidney In performing a hemnephrectomy it is usually wise to remove the infected area through a wedge shaped incision in the parenchyma so that the cut edges can be approximated more easily figure-of 8 mattress sutures being used After the sutures have been placed and drawn tight but not tied the constriction on the pedicle is removed in order to be sure that hemorrhage is adequately controlled If bleeding occurs it may often be stopped by placing a strip of muscle or fat between the cut surfaces

The technic of débridement is essentially the same as resection in the preliminary steps but instead of attempting to close the defect in the cortex it is packed with gauze or if there is no bleeding a rubber dam If the former is used it is well when it is to be removed in forty eight to seventy two hours to take the patient to the operating room anesthetize and drape him and gently remove the gauze The reason for this

pain This occurred above the upper pole of the kidney and a small abscess containing about 10 cc of pus was evacuated This abscess might easily have been missed if the patient had been unconscious

It is obvious that in all kidney infections foci of infection in the other systems of the body should be searched for and eradicated

**Kidney Injuries** —ETIOLOGY AND PATHOLOGY —Renal injuries usually are caused by contusion from a blow penetration by a bullet or knife or tearing due to bony injury chiefly fractured ribs With regard to the first of these injuries it is important to know that the blow necessarily does not have to be a severe one and numerous instances have been reported in which very insignificant trauma ha resulted in a kidney injury In the second of these it should be remembered that in nearly all instances of injury by bullet penetration and in most stab wounds injury of some intraperitoneal viscus also occurs In the third instance the pleura or peritoneum is very likely to be torn

Most urological textbooks classify injuries according to type —as cap ular parenchymal vascular pelvic and others with various combinations of the types For brevity and simplicity it may be said that the structures which can be torn are the capsule the parenchyma the pelvis and the ves els Any one of these structures or any combination of two or more may be injured The important clinical facts to be determined are first whether there i injury in the kidney and second whether it is trivial and may be treated conservatively (nonsurgically) or whether it is more severe and operative interference is indicated

DIAGNOSIS —The majority of kidney injuries are so slight that pain and hematuria (if the tear extends into the pelvis so that blood passes down the ureter) are the only symptoms These sub ide with rest in bed sedation and forced fluids to wash out the blood

In the more evere injuries where large tears are made in the cap ule and parenchyma the clinical picture i correspond

to some distant focus The focus is u ually an infection in the skin (furuncle boil carbuncle) the bone (osteomyelitis) or the chest (pneumonia empyema lung abscess)

DIAGNOSIS —Usually the clinical picture develops very slowly and it may be weeks before the patient consults a physician and by the time he does the original infection may have been forgotten having been so trivial The most common complaint i lassitude and a dull pain in the side Examination in the early tages is often inconclusive If the patient i hospitalized he may have a sli ht fever a degree or two each day and there may be some leukocytosis (9 000 to 11 000) with no marked change in the differential count Cystoscopic examination may be negative with sterile urine from the kidney and no di tortion or displacement of the kidney pelvis Abdominal examination reveal some tenderness on the affected side with little rigidity and no ma s palpable

The picture ju t described i seen in the early sta e of the disease The urolo i t may be suspicious of perinephritic ab scess but the positive finding are not conclusive enou h to ju tify advising operation so it seems indicated to exclude other pathological possibilities which might cause the symptoms such as append cit gastro ntestinal and gallbladder disease all of which are p o ed not to be pre ent Not infrequently by thi t me a mass palpable (or x ray examination shows obliteration of the psoas shadow scoliosi or distortion and displacement of the renal pel i ) and the diagnosi i established

OPERATIVE TREATMENT —The ope at ve treatment is exploration of the per enal fat until the ab cess i located opened and drained These absce ses are s m times d fficult to find therefo e it i often ad antageous to mploy nfiltration anesthes a so that with the patient cons ious a loc li ed area of tenderness can be located and explored In a recent ca e developing after empyema and pneum n a local anesthesia was used because it seemed undes rable to gi e an nhalation anes thetic When th perirenal area was explo ed no abscess was found until the patient was asked to say when palpat on el c ted

tomy can be carried out and if urinary extravasation is found injury to the pelvis or severance of the ureter must be deter mined and corrected In all surgical procedures judgment has to be exercised on the basis of the pathological findings and the proper remedial measures executed The general condition of the patient sometimes allows one to do only those things which in the circumstances are absolutely necessary to save his life

LATE SEQUELAE —Late complications of renal injury are per sistent urinary fistulae infection (abscess) in the perirenal hematoma encysted accumulation of a liquefied hematoma These occur as late sequelae and their diagnosis and treatment are well discussed in all standard urolo ical textbooks they can be diagnosed and treated leisurely at a base hospital and will not be described here

## URETER

Injuries to the ureter due to external trauma or penetrating missiles are quite rare although some instances have been re ported The symptoms are those of urinary extravasation The dia nosis is made by intravenous or if this is inconclusive by retrograde pyelography The treatment is drainage of the ex travasation and if the ureter is completely severed anastomo sis over ureteral catheter Subsequent ureteral dilatation to prevent stricture is important

## BLADDER

Traumatic injuries may result in contusions of the bladder which are of little consequence or they may result in perfora tions of the bladder with very serious complications

**Perforation or Rupture of the Bladder** —ETIOLOGY AND PATHOLOGY —The injurie may be produced in various way the mo t common being the *crushing type of inju y* involving fracture of the pelvis with perforation of the bladder by picule of bone *Falls* from a great hei ht or falls in which the perineum i pierced by a sharp object such as a picket fence occa ionally occur It is surprising that gunshot wound of the bladder do not occur more frequently

ingly more erious and severe shock is pre ent with the classical picture of hemorrhage Examination elicits local pain tenderness and often a mass If the peritoneum has been torn free fluid is present in the peritoneum Between the two extremes any degree of local and general reaction is po sible depending on the extent of renal dama e and hemorrhage plus injury to other organs

TREATMENT —Treatment of renal injuries depends on the extent of renal damage and ensuing hemorrha e In the more trivial injuries conservative treatment consistin of rest and sedation suffices In more severe injuries in which the clin cal picture and local examination indicate continued bleeding operative interference is necessary

*Preoperati e Measures* —Preliminary to operation certain diagnostic and therapeutic measures are in order Abdominal examination is necessary to determine the presence or ab ence of free fluid in the peritoneal cavity Its presence indicates either coincident rupture of a hollow vi cu or a peritoneal tear with intraperitoneal extrava ation of blood If the injured kidney is funct oning intravenous pyelograms may give a clue to the extent of the ext avasation When the patient s condition is sufficiently good to stand the instrumentation retrograde pyelography may be done for more accurate knowledge of the condition present In the final analysi the deci ion of whether or not to operate soon after injury i made upon the basi of whether or not the patient is continuing to bleed The conclusion that he i bleeding often rests on increase in the pulse rate lessen n of the pe ceptibil ty of the pulse continuin fall of blood pressure and increas n shock

The preoperati e therapeutic mea u es to be instituted are rest sedation the trav nou adm i tration of fluid and blood transfus ns

*Ope ation* —The operati e procedur depend upon tl e findings when the kidney has been exposed If the kidney has been irrepa ably dama ed neph e tomy should be d ne if the tear can be sutured and hemo rhage controlled sutu all that s necessary If one pole only severely damaged heminephrec

without time consuming procedures Many patients will have abnormal urinary findings such as gross hematuria and desire but inability to void

The presenting symptoms in *intraperitoneal rupture* of the bladder may be shock mild or profound associated with severe para umbilical pain Examination will reveal abdominal di ten tion and in a certain number of cases signs of fluid in the peritoneal cavity Evidence of peritonitis will become more pronounced as time goe on particularly if the urine is infected

*Extraperitoneal rupture* of the bladder frequently is a result of a crushing injury of the pelvis consequently attention may be focused on the injury rather than the rupture The initial symptoms of extraperitoneal rupture are usually minimal ex cept for possible disturbance in micturition and it i only when there has been pro ressive extravasation of urine into the peri vesical tissues that attention may be drawn to the bladder Sepsis closely follows extravasation

Diagnosis of rupture of the bladder may be made without question in a certain number of cases on the basis of the his tory and physical findings alone However if the diagnosis re mains in doubt there are certain procedures which can be em ployed in arriving at a definite conclusion

Caution should be observed in using any type of urethral in strumentation to avoid introducing infection into an otherwise sterile field

*Catheteri ation* of the bladder may demon trate an empty bladder on the other hand as has been reported the catheter may serve to remove urine from the peritoneal cavity through a large rent in the bladder Instillation and recovery of a given amount of sterile saline solution has been a time honored pro cedure but thi may be mi leading particularly if the lacera tion in the bladder i small

*x Ray exai inat on* of the abdomen following instillation of dye or air into the bladder may reveal the radiopaque medium in the peritoneal cavity or perivesical tissues

*Cystoscopy* i of questionable value because of the diff culty in locatin a small tear when the vision i ob cured by bleedin

*Instrumentation* —A small number of cases of traumatic perforation or rupture of the bladder are due to certain types of instrumentation With the advent and increasin popularity of transurethral re ection of the pro tate there are reports of perforation of the bladder by the instrument and in some instances of rupture due to explosion of the gase collected in the bladder

Litholapaxy should be employed prudently and skillfully lest the bladder wall be taken up in the jaws of the lithotrite and be crushed along with the vesical calculu

*Overdistention* —The most important contributing cause of rupture of the bladder i overdistention of thi or an Overdistention i frequently associated with alcoholi m and this combination plus an initiating factor provide the largest group of true ruptures In a smaller group the overdistention may be due to stricture of the urethra obstruct on at the vesical outlet produced by hypertrophy of the prostate and the obstruction found in certa n type of neurogenic d ea e of the bladder The rupture of the bladder in all these cases of overdistention may be di ectly att ibutable to a relatively inconsequential fall a k ck or blo v to the abdo ien

A real but rare da er i the overdi tention of the bladder while the patient is under spinal or other anesthesia

*Spontaneous Rupture* —Spontaneou rupture so called is produced by overdistention of a bladder which has some area of weakne s in its all This v eakne s may be due to a d vert culum or it may be attributabl to chan es produced by infection that is ulcers of the bladder wall or a gangrenous cystitis

DIAGNOSIS —Whether a case of perforated or ptured bladder i to terminate i death o n etu n to health depend on the speed and accu acy f the dia i

There are two typ s of ruptu e f the bladder—intraperitoneal and extrape toneal—and the type whi h s suffered n fluences to a great e tent the mm d ate and ub equent course of events The hi tory preced ng adm s on t th hospital may give suft c ent inf rn ati ) t ll i l g t be d

reau patients who participated in World War I are now ap proaching what we may term the prostatic age

Choice of Operation —The surgical measures employed for the relief of prostatic hypertrophy are *prostatectomy* by the suprapubic or by the perineal route and *transurethral resec tion* Approximately 15 per cent of all Naval and Veterans Bu reau patients with benign hypertrophy are treated by electro surgical resection and the remainder largely by operation by the suprapubic route The question as to operative route is con sidered to be relatively unimportant It is believed that if one operator has achieved good results for example with supra pubic prostatectomy and if in his opinion it i the operation of choice then this method alone should be employed if the phy sician is to be fair to both himself and his patient

Transurethral resection has most emphatically not replaced prostatectomy in the hands of Naval surgeons It is believed that transurethral resection is applicable to a definitely limited set of conditions but that when so confined its usefulness i unquestionable It is undoubtedly an ideal method for the re moval of the so called median bars for the relief of cicatricial contractures involving the neck of the bladder for moderately enlarged middle lobe hypertrophies for subcervical glandular hypertrophies and for obstruction coincident with inoperable carcinomas For large prostates where there is great median lobe hypertrophy enlargement of both lateral lobes or enlarge ment of both lateral lobe coincident with median lobe enlarge ment we are definitely of the opinion that tran urethral sur gery is contraindicated in the great majority of cases and that some type of open operation is preferable

Technic of Prostatic Enucleation in Suprapubic Prostatectomy —We wish to discuss briefly our method of enucleation in the suprapubic operation Following exposure of the bladder neck the index finger of the right hand is intro duced into the prostatic urethra as far as the apex of the pros tate gland By general palpation along the lateral walls of the urethra the line of cleavage and line of hypertrophy can usu ally be identified very easily The urethra is gently broken

A procedure which has been advocated recently and which has been used with some success is the intravenous administration of radiopaque dye and the takin of $x$ rays of the bladder as the dye is excreted by the kidneys This will serve to demonstrate the presence of dye outside of the confines of the bladder This method should not be employed in the presence of shock

Again it mu t be emphasized that satisfactory results depend on speed of diagnosi and rapid institution of treatment

TREATMENT —Laparotomy is generally indicated in cases of *int aperitoneal rupture* of the bladder The urine is removed from the peritoneal cavity the tear in the bladder is closed on the serosal surface and the torn peritoneum repaired and the peritoneal cavity drained The bladder is then opened and the tear on the muco al surface i repaired The bladder is then drained suprapubically

*Extraper toneal ruptu e* of the bladder i handled in the same manner except that the peritoneal cavity is not entered It is very important to establish suficient drainage of the perivesical ti sues in those ca es in which extrava ation has occurred

PROSTATE

The most common surg cal disea e of the prostate encountered in the Naval Ser ice are ben gn prostatic hypertrophy prostatic carcinoma and prostatic abscess

**Prostatic Hypertrophy**—INCIDENCE —The frequency of prostatic obstruct on has markedly nc ea ed in the period between 1921 and 1940 p incipally because of the large number of Veterans Bureau patients handled in the Naval hospitals For example duri a recent tou of duty c mpl ted by one of us (V H C ) at the Ph ladelphia N val Hospit l seventy nine prostatectomie were perform d in th te n month and of thi group only four ca es were in act ve or ret ed Na y pe sonnel while the remainin seventy five ca es repre e ted Veterans Bureau patients The re son for th s relat ve ncrea e in frequency of prostat c hypertr phy can r ad ly be understood when one recognize the fact that the majo ity of Veterans Bu

In a recent series of seventy nine cases *hemostatic bags* were used in but three cases once when there was severe hemorrhage twenty two days after prostatectomy and once also when bleedin continued beyond the customary postopera tive period in the third case a bag was inserted at the time of operation because of an unusual amount of bleeding

We are not advocating this method of prostatectomy and neither are we advocating the nonuse of the hemostatic bag We are simply bringing out the point that the above method has been used with excellent results As a matter of fact at the present time with the numerous satisfactory hemostatic bags on the market such as the Foley bag we can see no reason for their not being used thereby givin both patient and surgeon the feeling of additional security

The suprapubic tube havin been sutured into place with No 2 plain catgut is easily removable on the morning of the fifth day The tube is replaced with a metal disk type of suc tion tube which projects about 1 inch into the wound and is attached to the continuous suction apparatus This tube is changed daily until there is evidence of beginning bladder closure at which point the tube is removed and the suprapubic wound strapped together with adhesive tape Perineal prostat ectomy is performed according to the technic of Dr Hu h H Young

**Carcinoma of the Prostate**—Carcinoma occurs in both Navy personnel and Veterans Bureau patients in about the same frequency as reported in patients of equivalent ages in civilian hospitals Navy personnel as a rule are transferred from our Naval hospitals to the Malignancy Service of Memo rial Hospital New York City They are usually een by the Chief of the Genito Urinary Division at Memorial Hospital for an opinion as to the ad i ability of using radium or radon eed in the treatment (Radium and radon from a Government deposit are available without charge to Naval personnel at Memorial Ho pital but the Navy pays for all medical and other ervices ) Veterans Bureau patients after the diagnosis of carcinoma i establi hed are treated either in the Naval

through at this point on the lateral wall first on the patients left side and then on the ri ht and the anterior portion of each lateral lobe is then well separated This enucleation is temporarily discontinued at this point and the index fin er with the palmar surface directed toward the posterior urethral wall is withdrawn until the verumontanum is identified On the proximal side of the verumontanum and between it and the middle lobe the floor of the urethra i now transversely broken throu h This technic serves to liberate the verumontanum and ejaculatory ducts from the prostatic mass and in the large majority of ca es this maneuver will tend to pre erve these structure If the bladder neck i well dilated the index fin er and middle fin er then are in erted in the prostatic urethra and hooked over the anter or portion of each lateral lobe wh ch has p eviously been enucleated and the whole prostatic ma s is inve ted into the bladder at the same time peelin off any attached portio of mucous membrane

Immed ately follo ving the removal of the pro tate ery *hot packs* a e inserted nto the p ostatic urethra and steady pre sure is mai tai ed fo app oximately three to five minutes When the e packs are removed very little bleedi g vill as a rule be encountered The frayed ed es of the prostatic mucou membrane now are reflected back into the ureth a and a second hot pack is inserted Th s removed after a few minutes and any not ceable bleed n p nts ar und the neck of the bladder are l gated The bladder is clo ed w th a standard suprapubic tube sutured in pla e and w th a u ethral catheter size 24 cut off squarely and ith e e al addit onal open n on the bladder end placed i ide the sup apub c t be and secured by a safety pin

In this type of enucl at n the pro tate remo ed intraurethrally a d ery l ttle damage if any hould be done to the bladder eck Continuous su t on i immed at ly in t tuted and contin ou ly m ntained Att nt on invited to the fact that no hemost tic bag has be n used a d n pe mane t pack left in the p ostat fos a For a g e t numb r of yea s o e of us (V H C ) has carr d out th techn c and c n st te that no deaths occurred fron po tope at e he rhage

forms and followers can be passed and dilatation usually to 22 F can be obtained at the first treatment After a few days dilatation to 24 F should be effected this should be followed by dilatation with a Kollman instrument to 30 F or 35 F depending on the resiliency of the stricture In all of these manipulations *the use of force is to be assiduously avoided* because of the danger of tearing the urethra with the subsequent formation of peri urethral abscess or urinary extravasation It has been advocated that in very narrow strictures preliminary to instrumentation oil be injected into the urethra in order to dilate it so that filiforms may be passed This procedure is not recommended since experience has shown that oil emboli may occur which are fatal Filiforms and followers should be part of the armamentarium of every ship and hospital station

OPERATIVE TREATMENT —The treatment of impermeable stricture with acute retention i surgical The simplest operative treatment is *suprapubic cystostomy* When the bladder is opened it is often possible to guide a small sound or filiform through the urethra by a fin er placed in it and to dilate the urethra so that a retention catheter may be passed which should be left in situ to splint the urethra Suprapubic drainage i indicated for from five to seven days until it is safe to remove the suprapubic tube The urethral catheter should be changed as cleanliness demands

It sometimes happens that even with the finger in the urethra no instruments can be passed at the operating table In this situation cy to tomy i performed and in the majority of in stance it will be found five or six days later that it will be po sible to pas a filiform and followers probably becau e of the ub idence of congestion and swelling in the strictured area

If after cysto tomy the stricture cannot be passed a second operation is nece ary In this preliminary urethral injection of methylene blue solution which is immediately washed out erves to delineate the urethra without having enough left in its lumen to stain and ob cure the operative field An inverted V inci ion i made in the perineum and the apex of the prostate expo ed a in Youn s perineal pro tatectomy A small

hospital or transferred to Veterans Bureau ho pital where special facilities are available for the treatment of pro tatic carcinoma

Radical prostatectomy with a complete removal of the prostate with its capsule urethra neck of bladder both seminal vesicles and ampullae followed by anastomosis of the wide open vesical neck with the membranous urethra i the only known cure for carcinoma of the pro tate On the other hand patients who display clinically advanced carcinoma beyond the operative state with urinary obstructive symptoms are afforded relief in Naval hospitals by electrosurgical resection

**Prostatic Abscess** —Prostatic abscess i quite common in the Naval Service and usually occurs as a complication of on orrhea The abscess once positive diagnosis has been estab l shed i a surgical problem and for this reason every urolo ical surgeon should familiarize him elf with the techn c of perineal pro tatectomy which is essentially the same as that employed for prostatotomy The pract e of makin blind stab wound through the perineum for the relief of prostatic absces definitely is not good urological surgery A careful dissection with expo ure of the posterior surface of the prostate accord in to the Young technic i indicated with incision and properly instituted surgical dra na e

## URETHRA

The pathological conditi ns encountered in the urethra of particular inte est to the military surgeon are infection stricture peri urethral ab cess and rupture Of the infections gon orrhea is of course the most c mm n Its si ns symptom d agnos s and t eatment are comm n knowledge

**Stricture of the Urethra** —St ictu e of the urethra i u u ally the result of tra ma o ch onic infect on The symptom is g adual dimi ut on of the u inary tream ith increasing difficulty in vo ding and the t eatment dilatation hen the stricture is permeable and operation when the st cture i impermeable to the passage of fil fo ms

DILATATION —In th majo ity of in t nces f tricture fili

The most frequent site of rupture is the *membranous portion* of the urethra in which case the extravasation follows the course of Colles fascia in the perineum in the scrotal wall and over the abdomen under Scarpa s fascia but the penis is not often involved because of the fact that Buck s fascia is firmly attached around the ba e of the penis

If the rupture is in the *prostatic urethra* above Denonvilliers fascia the extravasation extend retrovesically and retroper itoneally and may later appear at the external in uinal ring If it occurs in the upper anterior part of the prostatic urethra the extravasation may appear suprapubically

*Treatment* depend on the severity of the tear If it involves only the mucous membrane rest in bed suffices Repeated ex amination must be made for extravasation which always re quires incision and drainage

## PENIS SCROTAL CONTENTS EPIDIDYMIS

**Ulcerative Penile Lesions** —*Chancroid* —Excluding syph ilitic chancre chancroid is the most common ulcerative lesion of the penis and prepuce It is a painful tender purulent ulcerat ing lesion usually in the coronary sulcu and by contiguity on the prepuce A frequent complication is fibrosis of the prepucial meatus requiring dorsal slit in order that local treatment may be instituted The diagnosis having been establi hed by exclud ing chancre with secondary infection (darkfield examination) the treatment is the maintenance of local cleanliness and ad ministration of sulfathiazole 15 grains four times a day A large proportion of these cases are complicated by infection of the inguinal glands occasionally requiring incision and drain a e Circumci ion should be delayed until the ulceration is completely healed

*G a n lo a Inguinale* —Granuloma inguinale i a familiar picture to everyone It i important to differentiate it from carcinoma (by biopsy and frozen ectio n) and from lympho granuloma in uinale (by the Frei test) Treatment is daily injection of 5 cc of 1 per cent tartar emetic

*Lymphogranuloma Inguinale* —This condition al o called

sound is then passed into the urethra until the strictured area i encountered and the urethra is opened at thi point and again at the apex of the prostate The urgeon then has the urethra opened distal and proximal to the stricture and is able with the aid of probes and careful di section to follow the urethra betwecn these two points The peri urethral scar i then excised a catheter passed through the urethra and the urethra clo ed o er it A rubber tissue drain is inserted to the ite of the urethral wound

In the event that it is not possible to follow the urethra between the two openin just described it may be nece ary to resect the strictured portion and anastomo e the urethra over a catheter which should be left in place for at lea t two weeks The catheter may be needed even longer if upon its removal urethral irrigation demon trate that the urethra ha not healed Failure to heal is ind cated by appearance of the irrigating fluid throu h the per neal wound If the catheter is removed before complete urethral healing a persistent urinary fistula will result

**Peri urethral Abscess**—Peri urethral absce s may be secondary to acute u ethriti or intra u ethral instrumentation in those cases in whi h exce ive rou hness has caused a urethral tear If the ab cess is in the *pe le portio* it will be confined by Buck s fascia and is cha acte ized by localized swellin pain tenderness and fluctuation Incis on and draina e are indicated The incision hould not be d rectly ove the ab ce b cause persistent u nary fistula may result but should be made about 1 cm away d th ab ce s d a ned by tu nel n under the skin

Abscesses form in the *m b anoi urethra* f llow the fa cial planes which will be b i fly outl ned n the di cu ion of urinary e travasat on

**Rupture or Tear of the Urethra**—R ptu e or tear of the urethra occurs as the result of trictu e n trum tation fractures of the bony pel s dir ct tr uma The ymptoms are difficult urinat on o inab lity t o d often u ethral bleedin and in m re e ere ca e v de ce f *t tas ion*

The most frequent site of rupture is the *membranous portion* of the urethra in which case the extravasation follows the course of Colles fascia in the perineum in the scrotal wall and over the abdomen under Scarpa s fascia but the penis is not often involved because of the fact that Buck s fascia is firmly attached around the base of the penis

If the rupture is in the *prostatic urethra* above Denonvilliers fascia the extravasation extends retrovesically and retroperitoneally and may later appear at the external inguinal ring If it occurs in the upper anterior part of the prostatic urethra the extravasation may appear suprapubically

*Treatment* depends on the severity of the tear If it involves only the mucous membrane rest in bed suffices Repeated examination must be made for extravasation which always requires incision and drainage

## PENIS SCROTAL CONTENTS EPIDIDYMIS

**Ulcerative Penile Lesions** —*Chancroid* —Excluding syphilitic chancre chancroid is the most common ulcerative lesion of the penis and prepuce It is a painful tender purulent ulcerating lesion usually in the coronary sulcus and by contiguity on the prepuce A frequent complication is fibrosis of the prepucial meatus requiring dorsal slit in order that local treatment may be instituted The diagnosis having been established by excluding chancre with secondary infection (darkfield examination) the treatment is the maintenance of local cleanliness and administration of sulfathiazole 15 grains four times a day A large proportion of these cases are complicated by infection of the inguinal glands occasionally requiring incision and drainage Circumcision should be delayed until the ulceration is completely healed

*Granuloma Inguinale* —Granuloma inguinale is a familiar picture to everyone It is important to differentiate it from carcinoma (by biopsy and frozen section) and from lymphogranuloma inguinale (by the Frei test) Treatment is daily injection of 5 cc of 1 per cent tartar emetic

*Lymphogranuloma Inguinale* —This condition also called

lymphopathia venereum is a disease of unknown etiology in which there is swelling and induration of the inguinal glands ometimes secondary to a trivial penile lesion It is diagnosed by the Frei skin test It often subsides pontaneously and if it does not excision of the glands may be indicated Exci ion of glands is the only curative treatment and must be done early In late stages strictures of the urethra and rectum occur

*Plageden c Ulceration of the Penis* —Thi is a fulminatin infection due to a Vincent like organism resultin in exten i e destruction of the penis and can often be successfully treated by zinc peroxide paste but in evere cases amputation i sometimes nece sary Even o the inc peroxide paste is valuable in the postoperative treatment

**Scrotal Contents** —*Testic lar Injuries* —Injury to the testicle is caused by a blow or a penetrating wound and is accompanied by great pain nausea vomiting and shock If the injury i sufficiently eve e hemorrha e into the tunica vagin ali may result in a large hematocele which may later nece i tate operati e correctio If there has been suff cient damage to the vessel the testicle may slough and have to be removed

*Tors on of tl e Sperm ti Cord* —Torsion of the cord usually occurs in boys at about the age of pube ty but may happen later in life Acute tors on cau e great pa n shock nau ea and vomitin The test cle become enlarged and exqu sitely tender and if the tor ion not reduced test cula slough may occur In the less severe instances of recurrent part al torsion with rap d reduction of it atrophy of the test cle may e entually re ult

Treatment operati The te ticle and co d are exp ed and if the te ticle ppe r to b i ble it t tu ed to the parietal layer of the tunica ag nali a e be n taken t to con trict the ves el or the ep didymi Becau e of the not f equent occurrence of torsion on both de the ret cally due to inadequacy of the guber acul m testis it ad i able to expo e the other test cle and d an chidopexy

**Epididymitis** —The th ee m st mportant fo ms of ep d dymiti are the t bercul us the gono rh al nd no specific

infections following urethral instrumentation or secondary to chronic prostatitis and seminal vesiculitis

*Tuberculosis of the epididymis* may be acute in the early stages and difficult to differentiate from other infections It is proved however to attack the lobus major and in time go through the stages of caseation and nodulation so that later examination reveals doughy induration of the epididymis and beading of the vas due to tubercle formation The skin may become involved and multiple sinuses develop Epididymectomy is indicated

*Acute gonorrheal and nonspecific infections* of the epididymis will usually subside with rest elevation and application of cold but in some cases abscess formation occurs which requires drainage

The testicle is not often involved in any of these infections except in the late stages If nontuberculous infections do not subside clinically in a week or ten days even without abscess formation *epid dymotomy* with multiple small incisions in the epididymis has been advocated There is some opinion that chronic infections of the epididymis chiefly gonorrheal are a source tending to prolong the disease or cause recurrent exacerbations in the urethra prostate and seminal vesicles *Epididymectomy* has been advised under these circumstances

*Technical Points in Epididymectomy* —The technic of epididymectomy deserves a word It should be remembered that the artery to the te ticle lies medial to the vas and epididymis so that if the testicle is turned in the hand the normal relation of these two is disturbed and injury to the artery may occur Therefore it is wise to avoid turning the testicle and to dissect from the lateral side of the spermatic cord The vas is isolated and dissected down as far as convenient The globus minor is separated from the testicle then the body and the globus major The denuded area at the rete testis is covered by suturing the tunica albuginea over it

S g l Cl f N tl A
D mb 1941

# SHOCK ITS PREVENTION AND TREATMENT

ALFRED BLALOCK M D F A C S

M C M N T AN AN C IR S
S N RESEARCH C U CIL P ES S ER J H
H U IVER TY S CH J H L H

THE evidence thus far in the present war indicates that the ratio of wounded to dead is approximately 4 to 1 which is essentially what it was in World War I The preponderance of shell wound over bullet wounds is probably even greater than in the war of 1914–1918 when 70 per cent were shell wounds resultin from high explosives The greatest change has resulted from the fact that the employment of more mechanized units has required that the facilities for rendering aid to the injured should be more mobile than in the past The base hospitals should be at a greater distance from the line of battle There should be more small hospital and fewer large ones owin to the danger of bombing from the air and the possibl necessity for rapid evacuation In other words it appears that mobile medical units should largely supplant the more or less stationary ones except for those that are at a great distance from the site of the engagement Greater perfection of organization is necessary Every unit should be completely equipped There is an even greater need than in the past for rapid and efficient ambulance service

## SHOCK

**Pathogenesis** —There is no unanimity of opinion as to the pathogene is of all instances of shock but all are agreed that there i a diminution in the effective volume of the circulating blood Thi may be due to a decrea e in the blood volume or

F m th D pa tm t f S g ry f th J h H pk ns U ty

**Prevention and Treatment** —Advances in the prevention of shock have more than kept pace with improvements in methods for treating the fully developed condition After the blood pressure and blood volume remain depressed for a considerable period general damage to the tissues occur as a result of the anoxia and no form of treatment results in a sustained benefit It is for this reason that our major effort should be directed toward the prevention of shock and the most effective form of therapy that is available should be given at the earliest possible moment

A number of points which are of importance in the treatment of the wounded with particular reference to the prevention and treatment of shock will be considered

### 1 GENERAL CONDITION OF MEN

There is no doubt that the general condition of the person at the time of injury is an important factor in determining the likelihood of the development of shock It was noted in the war of 1914–1918 that soldiers with adequate fluids did not go into shock as readily as those who had had insufficient fluids It is desirable that at least 2 liters of *water* in addition to that contained in the food should be available each day and that the quantity should be greater in very warm weather Food should be adequate in quantity as well as in composition An abundance of *protein* is especially important A good state of nutrition increases a person s ability to withstand infections and injuries Evidence indicates that adequate *vitamins* particularly vitamin C are of importance in the healing of wound and in combating infections

*Exposure to cold* with inadequate clothing increases the susceptibility to shock This is particularly true if the clothes are wet Dry garments should be available for replacement

### FIRST AID DRESSINGS AND SUBSEQUENT CARE

In addition to the control of hemorrhage and the splinting of fractures (points which will be considered subsequently) a number of points of importance in first aid treatment will be

to an increa e in the capacity of the vascular bed (va odilata tion) or to both Most instances of shock which result from trauma are associated primarily with a decrease of the blood volume and vasoconstriction It i for this reason as will be emphasized later that the main form of therapy consi ts of supplementing the reduced blood volume by the introduction of fluids rather than inducing va oconstriction by the use of dru

**Clinical Picture** —No attempt will be made to de cribe in detail the clinical picture of shock a condition with which all physicians are familiar The general appearance varies some what according to the acuteness of the onset and the severity of the disorder In *secondary* or *hematogenic shock*—the type in which the lo s of fluid is mainly from rather than into the vessels—the findings usually include a rapid thready pulse cold extremities (vasoconstriction) a pallid or rayi h appear ance reduced arterial pressure collap ed vein thir t super ficial rapid respirations lessened sensibility and hemoconcen tration or d lution depending on the relative losses of whole blood and plasma and the duration of the di order In *primary* or *neu ogenic sl ock* or collapse which is usually of relatively short duration the extremities are usually warm (vasodilata tion) rather than cold and the pul e may not be accelerated

It is important to realize that all *decl nes of blood pressure* are not of the same sign ficance For example a reflex decline of blood pre sure p oduces less damage than a decline of pres sure due to the loss of blood A a result of the compen atory vasoco triction that occur n s ondary o hemato enic shock the arterial blood pressu e may be normal in the presence of a definite reduction in the blood volume whereas in the type of shock accompani d by vasodilatation the blood volume may be normal or essentially so when the bl od pressure is de pre sed Thus t is evident that the blood p essure is inade quate as a sin le guide to the cond tion of the ci culation When possible seco dary shock hould be ecogn zed befo e the blood pressure declines The composite p cture p e ented by the patient s cond tion s frequently a comb nat on of refle and econdary shock

lowing receipt of the injury Delayed closure is advisable in older wounds It is inadvisable to perform a primary tendon suture if the wound was sustained more than six hours previously In the care of all wounds the time element is an exceedingly important factor

### 3 CONTROL OF HEMORRHAGE

**Tourniquet** —Hemostasis should be accomplished by measures which interfere as little as possible with the nutrition of the tissues For this reason a tourniquet should not be applied to an injured extremity unless other means of controlling the bleeding are ineffective Wilson and Roome found that the removal of a tourniquet is followed by the passage of a considerable part of the blood volume into the dilated vessels of the extremity and frequently by a decline of blood pressure

If the use of a tourniquet is found to be necessary it should be applied tightly enough to interrupt the arterial inflow to the injured extremity Occlusion of the venous return alone results in more harm than occlusion of both the arterial inflow and the venous return It is desirable unless the part is almost totally destroyed to release the tourniquet every hour in order to allow some blood to enter the extremity The tourniquet should not be covered with a bandage and the patient should be instructed to tell every medical officer who sees him that he has on a tourniquet In addition the fact and time of the application of the tourniquet should be recorded on the patient s Emergency Medical Tags One of the best types of tourniquet consists of a blood pressure cuff but such a cuff is not usually available If a standard tourniquet is not available it may be necessary to improvise one from a belt handkerchief or neck tie

**Other Measures** —As has been stated a tourniquet should be employed only when other means for controlling hemorrhage are inadequate Other measures include the causing of pressure on the artery between the wound and the heart elevation of the extremity the application of a tight dressing the insertion of a sterile gauze pack and if adequate facilities are available isolation of the vessel and the use of a clamp and ligature In occa

discus ed The care and promptness of the first aid treatme t of open wound are of great importance in determinin the likelihood of a sub equent severe infection It i preferable to leave a wound undres ed and attempt no fir t aid treatment than to treat it carelessly

The wound hould be adequately expo ed if nece ary by unbuttoning or cutting the clothing Pathogenic or ani m from human source frequently gain entrance into the wou d *after* rather than at the time of injury Unless profu e bleedin i taking place *wounds should be let alone* except for coverin with a sterile dressing until the patient i transported to a place where a eptic technic can be ob erved An exception i en countered in the care of a ucking wound of the chest Immediate clo ure by suture or by the use of adhesive is ind cated It is important to remember that the method for the removal of bacteria and othe forei n mate ial from wou d should b *mechanical* rather than anti eptic There are no effective anti septics whi h do not destroy ti sue In other word the im portant point i that wounds should be let alone except for the application of a sterile dressing provided the bleed n has ceased until mea s are available for prope care The wound should not be touched with the fin ers unsterile dressin or other unclean objects

It i too early as yet to as ess the value of bacter ostatic dru s uch as *s ll n la n de* in the p ophylax of wound infec tion It appears that ulfanilamide in concentratio s obtainable by local nt oducti n of the crystalline dru in sufficient amount will p otect aga nst i fection by holding the organi m in check until the local defensive forces have re ponded Ex perience may ho v t to be ad i able t supply all person i active w fare with one of the chemothe apeut c a ents to be taken b mouth or ppl ed locally n case of injury

After the pat ent reaches a point where adequate facil ties are pre ent scrupulou *m han l cl s n* of the wound hould be effected Follow ng d b dement it may be tated that in gene al p imary clo u e of wound may be carr ed out certainly up to eight and usually up to twenty fou hours fol

ferred from the scene of the injury In addition to the reduction of pain immobilization results in a lessening of damage to the soft tissues including blood vessels by the sharp bony fragments and for this reason it is particularly important in lessening the further loss of blood

**Splints** —The Thomas splint for leg or arm is ideal for the splinting of fractures but it is not always available at once Regimental surgeons should be provided with an adequate number of splints Most materials at hand such as pieces of lumber make poor substitutes even for temporary use The substitutes for splints should be padded well on the side that is next to the skin Further they should be bound securely by bandages or be tied above and below the point of fracture but not directly over it Fracture of the thigh are particularly difficult to treat by improvised means since it is important that traction be applied Every effort should be made to obtain the proper type of splint before the patient is transported any considerable distance The future will witness an increase in the use of wires and pins for insuring fixation and traction

**Anesthesia for Reduction of Fractures** — *Infiltration anesthesia* has been found to be satisfactory for the reduction of fractures particularly those about the ankle and wrist The needle is inserted directly into the hematoma and the solution is injected Satisfactory anesthesia can usually be obtained within five to ten minutes by injecting 10 to 20 cc of 1 per cent procaine Thi method should not be used in cases of compound fracture

### 6 HEAT

A definite relationship exists between the incidence of shock and the loss of body heat and an effort should be made to prevent and to correct excessive chilling During the examination and treatment the injured man should be subjected to as little exposure of the body as possible When possible preliminary dressing of wounds should be performed in a warm place Heat is lost especially rapidly through wet clothing Dry garments should be substituted as early as possible All ambulances should be equipped with heating devices

sional cases it i necessary to ligate the artery proximal to the wound through a separate incision The method that i used depends on a number of factors includin the nature of the wound and the facilities available for its care

## 4 RELIEF OF PAIN

There is evidence that *morphine* in moderate sized do e is of aid in the prevention of shock Except in the case of evere intracranial damage it should be given for the pain and restlessness associated with injuries before the patient is moved from the scene While it is possible to admini ter too much morphine and to add to anoxia already present in shock usually / to 1 grain should be given to the everely injured *Sodium phenobarbital* in moderate amounts may be given for the re tles ness associated with intracranial injuries

A therapeutic aid of possible value in the prevention of shock may be found in the use of *sodium amytal* Seeley Es ex and Mann found that the tolerance to trauma in experimental animals is defin tely greater under sodium amytal or sodium amytal preliminary to ether than under ether anesthesia alone It is po sible that the development of shock may be delayed by such therapy In so far as I am av are th drug has not been given a clinical trial for thi purpose except at the Walter Reed General Ho pital v he e Metcalfe reports favorable results from its use

Another possible aid in the prevention of shock follov in injuries to the legs may lie in the production of *sp al anesthesia* a su e ted by O Shaughne sy and Slome Th procedure would appear to be inad i able inasmuch as pinal anesthesia alone is frequentl ac ompan ed by a mark d decl ne of blood pres ure

## 5 IMMOBILIZATION OF FRACTURES

One of the greatest dvanc s in urgery that esulted from the la t war co si ts of ipr vements n method of dealin with fractures Fractures of the long bones sh uld be immobil ized by the best means ava l ble befor the patient is trans

internal temperature and excessive heat may result in ill effects Furthermore the patient in shock is usually dehydrated and the application of heat with resultant sweating will exaggerate the condition These last few remarks are in no sense a criticism of the extremely important principle that the patient should be kept warm but it should be emphasized that a marked elevation of the skin temperature should not be caused unless at the same time the reduced blood volume is supplemented by the introduction of blood or blood substitutes

### 7 SHOCK POSITION

There is no unanimity of opinion as to the value of the so called shock position in which the foot of the bed is elevated thereby placing the patient s head on a lower level than his feet Observations made durin World War I did not present any convincing evidence of benefit to the patient However it i possible that lowering the patient s head increases the blood flow to the brain It is well known that nerve tissue withstand a poor blood supply le s well than others Another theoretical benefit that might be derived from this po ition is the facilitation of the venous return from the large abdominal vascular area However since most of the blood is not in the large veins but elsewhere it seems doubtful if the position i important in this respect There is no proof that the blood of the portal vein can be made to pa s through the liver capillaries by gravity drainage Wells and his associates recently presented evidence that lowering the head and flexing the neck on the chest increase the cardiac output and improve the condition of the animal in shock It is my impression that the shock position should be part of the therapy of patients in shock

### 8 VASOCONSTRICTOR DRUGS

A number of va oconstrictor drugs have been recommended for the treatment of shock Included among the e are epinephrine ephedrine cafteine camphor neo ynephrin hydrochloride ether strychnine coramine cardiazol pitressin benzedrine paredrine and paredrinol As stated previously

**Devices for Supplying Heat** —A number of device may be used for supplying heat If *blankets* are available they should be placed around the patient wherever he may be As Cannon has emphasized more blankets are needed under the body than over it The reason is that the blanket protects the body again t loss of heat by the air which it holds enmeshed in its fiber The weight of the body lessens the air pace in the fabric and reduces the amount of protection from the under surface Since there is usually a scarcity of blankets in time of war they should be u ed as efficiently as possible

There are various other means for supplyin heat The e in clude the use of *canteens* or *bottles* filled with hot water and of *warm stones or bricks* They should be placed outside the cloth ing in order to prevent burns and should be located between two surfaces such as between the leg or between the arms and the chest In addition the patient should be given *hot drinks* unless there are contraindications such as a penetrating wound of the abdomen The fluid supplements the reduced body flu d in addition to supplying heat If fluid cannot be retained when given by mouth as is so often the case in the conditions of the severely wounded warm liquids may be given per rectum Marked impro ement usually occu s in the cold wounded pa tient when he is placed n a *warm bed* It may be possible to place electric lights unde a cradle which i over the bed or a lantern may be placed on the floor beneath the bed or stretcher which should be dressed with blankets to provide fo retention of warm air beneath it

**Dangers in Excessive Heat** —It should be borne in mind that excessive heat may re ult n ill effects as severe as those from e cessive cold In patients n se ondary (hemato enic) shock there is a dim nution in blood volume and vasoconstri tion The extremit es re cold but this coldne s i i part due to the fact that the blood s div rted ma nly to the more v tal structure the he rt and b a n Exc s i heat may cause d la tation of the essel near th su fa e of the body and the flow through the more vital pa ts will suffe cor esp ndingly Cold extremities may be assoc ated with a d fin te ele ation of the

internal temperature and excessive heat may result in ill effects Furthermore the patient in shock is usually dehydrated and the application of heat with resultant sweating will exaggerate the condition These last few remarks are in no sense a criticism of the extremely important principle that the patient should be kept warm but it should be emphasized that a marked elevation of the skin temperature should not be caused unless at the same time the reduced blood volume is supplemented by the introduction of blood or blood substitutes

## 7 SHOCK POSITION

There is no unanimity of opinion as to the value of the so called shock position in which the foot of the bed is elevated thereby placing the patient s head on a lower level than his feet Observations made during World War I did not present any convincing evidence of benefit to the patient However it is possible that lowering the patient s head increases the blood flow to the brain It is well known that nerve tissues withstand a poor blood supply less well than others Another theoretical benefit that might be derived from this position is the facilitation of the venous return from the large abdominal vascular area However since most of the blood is not in the large veins but elsewhere it seems doubtful if the position is important in this respect There is no proof that the blood of the portal vein can be made to pass through the liver capillaries by gravity drainage Wells and his associates recently presented evidence that lowering the head and flexing the neck on the chest increase the cardiac output and improve the condition of the animal in shock It is my impression that the shock position should be part of the therapy of patients in shock

## 8 VASOCONSTRICTOR DRUGS

A number of vasoconstrictor drugs have been recommended for the treatment of shock Included among these are epinephrine ephedrine caffeine camphor neosynephrin hydrochloride ether strychnine coramine cardiazol pitressin benzedrine paredrine and paredrinol As stated previously

however vasodilation is rarely present in secondary shock except in the terminal stages and induction of further vasoconstriction in early stages may result in harm rather than benefit. The elevation of pressure which follows the injection of such drugs results from an increase of resistance in the tips of the arterial tree As Cannon has stated damming the blood in the arterial portion of the circulatory system at a time when the organism i suffering primarily from a dimini hed quantity of blood does not improve the volume flow in the capillarie Merely a higher arterial pressure is not the aim in the treatment of shock but rather a higher pressure which transmit an increased blood flow through the capillaries all over the body This can be accomplished in secondary shock only by increasing the blood volume

In primary or neurogenic shock which is usually of only short duration the use of vasoconstrictor drugs may be ind cated For example the vasodilatation and the decline of blood pressure which may be associated with the production of pinal anesthesia should be treated by the injection of a vasoconstrictor drug such as ephedrine

In general it may be stated that the employment of vasocon trictor drugs i rarely indicated in the treatment of shock

9 INTRAVENOUS FLUID ADMINISTRATION (INCLUDING BLOOD)

Intra enous fluid admin tration is the most important sin le form of therapy in the p evention and t eatment of shock The simplest mea s of p oduci g an increase in a educed blood volume by g ving fluid by mouth Unfortunately however vomitin likely to ccu if shock is pre ent Even though vomitin does not occur the abs rptio of fl d may be greatly retarded and delay is not perm ssible If the givin of fluid by mouth is cont a ndicated it may be admin tered by hypodermoclysis or pe rectum These route nclud ng the oral one have the common obj ction that absorption is markedly retarded when shock i present The impo tance of not allowing the blood olume to remain depres ed and of increa ing it at the earl est possible mon nt ha been m tioned Further

more the intravenous route is the only entirely satisfactory one for the introduction of whole blood and serum and plasma

**Isotonic Salt and Glucose Solutions** —*In Prevention of Shock* —Although normal saline and 5 per cent glucose are indicated at times in the treatment of shock it is in the prevention of shock that their greatest usefulness lie The best example of their effectiveness is in *dehydration* which may lead to shock and which should be treated by the intravenous introduction of solutions of crystalloids if oral or other means of administration are contraindicated or do not suffice The electrolyte content of the body is severely altered in protracted vomiting or diarrhea and the introduction of an adequate quantity of an isotonic solution of sodium chloride is indicated In addition water should be supplied in the form of 5 per cent glucose Among other beneficial effects this solution supplie the kidney with fluid with which waste products may be excreted

*In Treatment of Shock* —The intravenous injection of isotonic solutions of crystalloids in existing shock has at best only a temporary beneficial effect The fluid passes from the capillaries into the tissue spaces and within a short period the blood pressure and blood volume are as low as before if not lower Furthermore it has been demonstrated both clinically and experimentally that some of the protein of the blood plasma escapes with the fluid that is lost from the capillaries This loss results in a diminution of the protein content of the blood plasma and in a reduction of the osmotic pressure A marked reduction in the osmotic pressure is of grave significance since it results in the further loss of fluid from the blood stream It is particularly important in the presence of gross tissue damage such as occurs when large masses of muscle are injured that large quantities of normal saline or glucose should not be given intravenously The same is true in cases of burns A protein containing fluid has been lost and it should be replaced by a similar protein containing fluid

It should be emphasized that solutions of crystalloids have a place in the treatment and particularly in the prevention of

hock but they hould not be used to the exclu ion of colloidal olution such as plasma and large quantities hould not be given intravenously

**Hypertonic Solutions** —There are few occasions on which the employment of hypertonic salt or gluco e olution is indicated in the treatment of shock The higher o motic pressure of a concentrated solution does attract water into the blood stream for a short time but the capillary wall i freely permeable to salts and a rapid filtration into the extravascular space ensue As ha been stated in the d cu sion of isotonic solutions protein i lost in the pre ence of capillary dama e with the fluid that e capes Therapy should be directed towards adding fluid to the body rather than toward attemptin to attract fluid from the already dehydrated tissue paces into the blood stream

The most definite indication for the u e of hyperton c solutions i encountered in the hock that accompanies severe *head inju y* A more rational form of therapy in that it reduces the cerebrospinal fluid pres ure without adding si nificantly to dehydration consists in the u e of a concentrated olution of dried plasma

**Gum Acacia Solutions** —Gum acacia solution 6 per cent in 0 9 per cent saline were used to some extent in 1914–19 A numbe of evere reactions and fatal ties were as ociated with its employment Althou h method of preparation have improved somewhat since that time it has gained little if any in popula ity Acac a be ng collo dal in contrast to alt and glucose rema n in the blood tream fo a longer time Dama e to carbohydrate and pr tein metabolism may accompany it use It i rathe generally bel e ed that acac a should ne er be used if whole blood o plasma s a ailable

**Whole Blood Transfusions** —Alth ugh blood may be obtained for tra sfu ons from the huma cada er the placenta and from suitable donors the latte appear to be at present the only enti ely suitable source A gr at mpetu to the u e of transfusions has resulted from the use of *blood banks* which had their ori in in W rld War I The principle underlyin

blood preservation is that the blood corpuscles undergo no noteworthy change if the blood is kept at a temperature between 0 and 5 C Coagulation is prevented by the use of sodium citrate The blood should be withdrawn from the donor directly into a container which has been cooled and then placed immediately in a refrigerator Hemolysis is retarded when large amounts of glucose are added to the blood but the dilution factor is objectionable Some alterations occur in preserved blood such as the migration of potassium ions from the cells into the plasma but blood which is used within eight days following its withdrawal is usually quite suitable for the purposes under di cu sion If evident hemolysis occurs the blood should be discarded As Plass and others have emphasized the blood should not be warmed before it is introduced into the recipient but should be given in the cold state at a slow rate

The usefulness of whole blood banks in time of war would appear to be subject to many limitations A large expensive cumbersome cooling unit is necessary The length of time that blood can be preserved with safety is limited Compatibility tests are necessary and these require time and cause delay The agitation which is associated with transportation probably decreases the len th of time that whole blood can be pre erved with safety These and other disadvantages make it impracticable to employ blood banks in the field and in dressing stations and it will probably be only in the base ho pitals that a blood bank will prove to be valuable It was found in the air raid casualties in Spain that at least 10 per cent were of serious enou h character to require the transfusion of blood The effects of the motion of ships and airplanes on the pres rvability of blood has not been determined

Nothing has been said about the ordinary methods of direct and indirect transfusions procedures which are familiar to all physicians Emphasis is placed on blood banks or stocks of blood substitute because they make for less delay in treatment of the wounded There is the urgency for using blood or some sub titute for it a early as possible in order to avoid the ir

reparable damage that accompanies a prolonged low blood volume

*Proper Quantity to Administer*—Apparently becau e the usual quantity of blood that is removed from a donor is 1 pint the usual quantity that i given to the patient is 1 pint Thi i as illogical as giving the same dosage of insulin to all patients with diabete The quantity of whole blood or of plasma should be gov rned by the needs of the patient If 1 pint is not s ffi cient to restore effective blood volume it does not follow nece arily that 3 or 4 pints will not result in permanent benefit One of the greatest advantages of these supplies of preserved blood and plasma i that larger quantities than could otherwise be offered usually are given

**Blood Plasma and Serum**—*Rationale of Their Use*—The instances in which the wounded d e from the lo of red blood corpuscles are relatively few in number A per on may remain *in relatively* good condition with a tremendous decrea e in the number of red blood corpu cles in the circulation provided that the plasma volume is not markedly reduced Most persons who d e because of the loss of red blood corpuscles do so before medical aid is available

It is realized that the e statements are omewhat incon si tent in that the loss of red corpu cle in injuries i accom pan ed by pla ma lo s The important poi t and the one that should be emphasi ed is that the lo s of *red co puscle* i u u ally tolerated quite well if the plasma loss i replaced It i usually unnece sary to repla e the red corpuscle if the fluid part of the blood is ava lable for intravenou njection It i unusual for a patient to lose more than 3 o 4 pints of whole blood as the decline of bl od pressure will usually result in a retardation or cessation of the ble ding Thi lea es app oximately three fourths of the red corpu cles w th n th *blood ve sel* If an ade quate quantity of plasma can be introduced the red corpus les put into mo e active ser ce are more than adequate to ma n tai life The introduction of plasma protein will pro ide the neces ary o motic pressu e to ke p the fluid the e l pro

vided it is given early and provided the capillary damage is not too extensive

In many types of diseases and in injuries such as burns the loss of the blood volume is almost entirely plasma very few red blood corpuscles escaping Fortunately the preservation transportation and administration of plasma or serum present far fewer problems than does the use of whole blood It is a safe prediction that the administration of plasma or serum in warfare will largely replace that of whole blood

*Sources*—Plasma is obtained from blood which was prevented from clotting by the addition of an anticoagulant such as sodium citrate whereas serum is the fluid part of blood which has been allowed to clot The most important constituent of each is protein The main difference is that plasma contains fibrinogen whereas serum does not The yield of plasma by a given quantity of blood is somewhat greater than that of serum One of the reasons that plasma has been used more extensively than serum is that after unclotted blood has passed its age of usefulness the plasma may be drawn from it

*Relative Virtues of Plasma and Serum*—There is some difference of opinion as to the relative virtues of plasma and serum particularly in regard to the safety of administration Serum is preferred by some physicians because it does not contain sodium citrate and fibrin precipitates do not occur On the other hand some observers have found that the use of plasma is associated with fewer unfavorable reactions than is the use of serum This fact is said to be due to the presence in serum of vasodilator or constrictor substances produced in the act of clotting

*Advantages of Plasma or Serum over Whole Blood*—The use of plasma or serum presents many advantages over whole blood particularly in the treatment of war wounds Included among the favorable points for plasma and serum over whole blood are the following (1) they may be stored for months at a cold temperature without significant alteration (2) they may be kept for a number of days at room temperature the exact length of time not yet having been determined (3) they

can be transported with less difficulty (4) they can be used without danger of severe reactions without preliminary laboratory typing and compatibility te ts particularly if the fluid of different donors is pooled thereby suppressing iso a luti ins (5) they are ready for instant use and (6) they do not add to the concentration of the red blood corpuscles hemoconcentration being the u ual finding in shock Whereas the use of plasma has enjoyed the greater popularity up to recently the pendulum appear to be swinging to the u e of serum

*Dried Preparations* —When refrigeration facilities are available frozen plasma or serum would seem to meet blood requirements On the other hand it is obvious that certain advanta e including indefinite preservation without regard for temperature as well a easier transportability will result from their conversion into powder A number of method of conver ion are already available and it is likely that improved ones will b forthcoming The ideal at the moment appears to be to have as much blood plasma or serum as po sible in the dried form This will reduce to a minimum the problems of preservation and transportation The plasma or serum can then be brou ht to the desired volume at the time it is to be given intravenously simply by the addition of sterile d tilled water It is not necessary to warm the solution and it should be given fairly slowly preferably not more than 50 cc per minute The disadvanta s of the dried forms nclude d ft culty of pre ervation and the tin e and trouble required to esto e them to the l qu d state

Dried plas na should b p epared from liquid plasma that has not been kept in the liquid tate for more than two day It is important that the dried plasma should be protected from moistu e by sealin unde vacuum in a suitable contai er Very little mo ture is requ red to spoil the material Strumia states that dried plasma h h is adequately p otected from moi ture will ma ntai it eff cti ene s in the treatment of shock for an indefinite period of time ert nly for one year at least

*Resu né* —To reiterate probably the in le n o t effect e valuable and p act cal meth d for th p event n and treatment

of shock with the possible exception of methods of hemostasi consists of the intravenous introduction of adequate quantities of blood plasma or serum Owing to the efforts of many scientist including a committee appointed by the National Research Council and the cooperation of the Army and Navy Medical Corps and various pharmaceutical houses it appears that frozen and dried plasma and serum will be available in adequate amounts for all emergency purposes

**Other Fluids** —Fluids in addition to those that have been mentioned that may in the future prove to be of practical value in the prevention and treatment of shock include *hemoglobin Ringer s solution ascitic fluid* and *amino acid mixtures* The employment of all of these at present is in the experimental stage

**Comment** —It is important to bear in mind in the treatment of the injured that the intravenous introduction of very large quantities of salt or glucose solutions may actually result in harm rather than benefit When in the course of treatment it is found that the plasma protein is decreasing while the concentration of red blood corpu cle is increasing one is forced to conclude that plasma is bein, lost from the blood stream and nothin i being accomplished Tissue edema rather than an effective increa e in the blood volume occurs In these circumstances the employment of a colloidal solution such as pla ma or whole blood is imperati e

### 10 FLUID ADMINISTRATION BY OTHER ROUTES

Brief mention has been made of the use of routes other than the intravenous one for the admini tration of fluids The use of the e routes is of much greater value in the prevention than in the treatment of hock The ab orption of fluid is markedly retarded or aboli hed in per phe al circulatory failure Unfortunately the patient in shock u ually vomits when fluids are taken by moutl Tl e e remarks are not intended in any en e as a critici m of the e method of admini tration in tho e cases in which fluid can b retained and absorbed

I otonic alt or gluco e olutions may be given by *hypo*

*dermoclysis* The site chosen is usually the subpectoral region or the thigh The latter is usually preferable unless contra indications exist because there is less interference with normal respiratory movements The most frequent indications for the giving of fluid by hypodermoclysis arise from persistent nausea or diarrhea peritonitis and various operations on the intestinal tract These conditions are such as may lead to shock and should be treated by adequate fluid administration

The *rectal route* is suitable only for the introduction of water More complicated solutions are absorbed very inadequately when introduced by this route

## 11 OXYGEN INHALATION

The oxygen content of the arterial blood is usually essentially normal in shock but that of the venous blood is greatly reduced (stagnant anoxia) The inhalation of 100 per cent oxygen results not only in an increase in the amount of oxygen in chemical combination with hemoglobin but also in a substantial increase in the amount of oxygen in physical solution in plasma There is a resulting increase in the pressure of oxygen in the tissues High concentration of oxygen can be more effectively and cheaply administered by use of the Boothby mask than by any other available means If the respirations are depressed carbon dioxide should be added to the oxygen

Although there are a good many theoretical and practical reasons for the administration of oxygen in shock the results of such treatment are not striking During the exigencies of warfare it is doubtful if the benefits that result would be worth the time and effort The transportation of large tanks of oxygen presents a difficult problem Certainly the routine administration of oxygen in shock should not be carried out if it interferes with some of the more necessary and beneficial procedures

## 12 ADRENAL CORTICAL EXTRACT

Points of similarity between shock and Addison's disease have suggested the use of adrenal cortical extract in treatment

Potent extracts have been available only in recent years and it is too early as yet to asses the value of this form of therapy Possible beneficial effects may result from decreasing abnormal capillary permeability or by reducing hyperpotassemia Scudder su ests that the use of cortical extract should be combined with that of hypertonic salt solution From the evidence presented thus far it is not justifiable to rate adrenal cortical extract as one of the more valuable agencies in the treatment of sho k but the reports on its use are encouraging

## 13 TIME OF OPERATION

There are many reasons for early operations on the wounded Particularly are they advisable in those instances in which bleeding cannot be stopped by other means and in those in which penetrating wounds have been received in hollow organ such as the intestinal tract As has been stated the length of time separating the injury and operation is an important factor in determining whether wounds should be closed by primary suture whether tendons should be sutured and whether shock and other complications will develop following penetrating wounds In general it may be stated that *the mortality rate varies directly with the hours intervening between the major inju y and the operation* However thi does not imply that an immediate operation i indicated if the patient i obviously in too poor condition to tolerate the procedure

When the general condition of the patient does not permit immediate operation an attempt should be made to improve it by the use of simple mea ure such as the admini tration of fluid warmth and re t The depres ed blood volume should be supplemented by the intravenou introduction of blood plasma or whole blood If the systolic blood pre ure has already fallen to the critical level of 70 to 80 mm of mercury it must be realized that the condition i very grave that only a little additional trauma or los of blood will result in profound shock and that intelligent therapy is required

When the patient in previou ly poor condition has been made ready for the operation long and complicated operative pro

cedures should be avoided and the principal le ion hould b treated as quickly as the correct type of surgical technic will allow At the ame time body heat should be preserved every effort should be made to prevent further lo s of blood the ti sues should be handled as gently as po sible and very p o found anesthe ia should be avoided In other words careful surgery i indicated but piddling is to be avoided The results of recent experiment by Beecher indicate that cyclopropane is the best of the general anesthetic agents for patients in hock

## 14 PENETRATING WOUNDS

Penetrating wound do not form a part of thi discu sion except for the fact that their improper treatment i likely to lead to shock Several dogmatic statement to hich there are undoubtedly exceptions will be made in regard to the sur ical care of patients with such wound

**Brain.**—All penetrating wound of the brain are acute s r g cal emergencie and hould be treated by ea ly removal of badly damaged ti sue includin devitalized bone fragments and tho e foreign bod es the removal of which will not increa e the damage already sustained by the brain If facilities are avail able the irri at on suct on technic should be u ed Such wound should be clo ed if operated upon within twel e hours althou h subsequent e opening may be nece sary Local anesthe ia with ad enal n added i u ually adequate

**Chest**—As has been stated sucking wound of the che t hould be clo ed at the earlie t po sible moment If injury to the heart and reat e sels can be xcluded and if foreign material such a dirty cloth n n t carried into the che t by the a e t cau i the i jury p etrat n ound of the chest should usually be t eat d by n noperat mean If the wound i in the left lowe po t on of the che t n the re io of the diaphragm bd minal e plo at on i ind cated be au e of dan ger of penetrat on of th stomach or splenic flexure of the colon If the wound i in the ight lower port on of the che t in the region of the diaphra m xplo at on i not u ually i d cated If the ite a d nature f th j v ig e t lamage to th

heart evidence of *cardiac tamponade* should be sought The two best evidences of cardiac tamponade are (1) suppression or absence of pulsation of the heart under the fluoroscope and (2) a prominence of the veins and an increase of the venous pressure The treatment of cardiac tamponade i open operation with suture of the heart wound

**Abdomen**—All surgeons are agreed that exploration is indicated as early as is feasible in penetrating abdominal wounds Perforations of the intestinal tract should be closed or if it is impossible to close them resection should be performed Intestinal distention which may lead to shock should be prevented or treated by the employment of duodenal suction intestinal intubation and inhalations of high concentrations of oxygen Wounds of the bladder should be closed and a catheter inserted If the spleen is badly lacerated it should be removed Unless a kidney is too badly damaged to function it should not be removed

# MILITARY ORTHOPEDICS

NORMAN T KIRK M D F A C S

C el Med al C U ited S A Chief f S cal Ser ce
Wal er Ree Gener H s l W hin D C

MILITARY orthopedics is the adaptation of the principles of civilian orthopedics and traumatic surgery to the evacuation and treatment of war casualties The basic surgical principles in the treatment of a given compound fracture are the same but the conditions under which the treatment can be carried out are quite different

## MANAGEMENT OF COMPOUND FRACTURES IN CIVIL LIFE

In civil life the transportation of the casualty from the site of the accident to a well equipped and well staffed emergency room in a general hospital i a minor consideration The time lag is minimal and should fall well within the six hour period of wound contaminations Proper splinting with a traction fixa tion plint in fractures of shafts of long bones at the site of the accident is a simple procedure its importance is accepted and practiced by all surgeons who treat fractures The necessity of this type of splinting as a first aid procedure was well demon strated in World War I By its use pain i reduced to a mini mum and shock is well as further injury to the soft parts of the injured member is markedly prevented

For many years the Fracture Committee of the American College of Surgeons both by its own efforts and through tho e of its Regional Fracture Committee has carried on a crusade to institute thi procedure as a first aid treatment

On arrival of the patient at the emergency room if a splint ha not been applied to the fracture one is applied at once

Th r se t t ed h re th p at es f th ter 1 t t be t ed fi I flect g th f th W Dep tm t th m l t serv t larg

The patient i critically examined by a well trained adequate staff to determine the types of injury that he has su tained and the presence or ab ence of shock If shock is present adequate treatment is instituted at once by the u e of intra venous replacements such as aline solution solution of glu cose blood plasma or erum or citrated whole blood While treatment i being carried out clothing is removed the wound or wound are examined and $x$ ray studies of suspected frac tures are made The patient i taken to the operatin room and if the fracture is compound thorough debridement i car ried out while treatment for shock is continued The plint i not removed until the patient is anesthetized The fracture is reduced and fixed in reduction by the method elected by the surgeon Internal fixation of the fracture by the u e of plates and screw i carried out by many surgeons The wound may or may not be clo ed Some surgeons advocate closure if the wound is not grossly contaminated if the time lag i well under six hours and if closure can be accompli hed without tension Several grams of sulfanilamide or sulfathiazole are prayed into the wound before it is closed A skin ti ht plaster cas ng may be applied or the patient may be placed i bed the fractured leg uspended on a Thomas splint and wei ht and pulley traction nstituted

Kennedy and oth rs condemn the primary clo ure of any compound fracture Afte the use of inte nal metal fixation light aseline pa ks are applied to the wound and a skin ti ht cast is applied

Sherman susp nd the fractu ed extremity after nternal fi ation and irr gat s the wound w th Dakin s olution Wil on prefers the Ro er Ande on dual p n reduction fixat on method and applie a plaster nca ement after praying the wound with sulfathia ole and us n a va el ne gauze pack Key be l eve that pr ma y closu follo ing pr per debridement and spraying of the wound with sulfathia ole and ulfanilamide is a safe p ocedu e even up to e ght hours afte injury Orr con demns the use of any of the sulfonam de r up of d u s in the wound He prefers u e of the va eline pack only ith fixa

tion of the fracture in plaster Many of us still are of the opin ion that debridement followed by administration of sulfathia zole and use of a bismuth iodoform and paraffin gauze pack (bipp) to be followed by suspension and skeletal traction by means of the modified Thomas splint with infrequent dress ings is the procedure of choice Many compound fractures particularly the comminuted type that result from gunshot wounds cannot be treated physically by internal fixation due to the comminution or loss of substance in the fractured bone

In civil life the patient goes from the operating room to the bed in the hospital to which he was originally admitted and is under the continuous observation of the surgeons who pri marily treated his fracture As I shall later point out this pro cedure is impossible in war

## WAR INCIDENCE OF COMPOUND FRACTURES

Love s stati tics (tabulation) show that more than 30 per cent of all battle casualties which resulted from gunshot wounds in the experience of the American Expeditionary

TABULATION

B TTL C ES G W DS L A E ED TI
F W R ES 1000 T C ES AN P D
Acco Lo

| | F q p 1000 | D th R t P C t |
|---|---|---|
| S ft tiss pp t m t | 198 61 | 4 27 |
| C mp u d f t h d d w t | 118 23 | 1 47 |
| C mpo d f t l l h m p l | 3 74 | 9 46 |
| C mpo d f t d d l | 30 24 | 4 36 |
| La g bl d l d pp t m t | 13 36 | 7 11 |
| S ft tiss l t m ty | 333 86 | 6 09 |
| C mp d f t f m t b f b l k j t | 0 5 | 17 53 |
| C mpo d f t kl d f t | 6 79 | 2 56 |
| C mp d f t p l | 4 22 | 26 98 |
| L bl d el d l t m ty | 3 33 | 11 90 |
| Soft ti f f d h d | 59 19 | 2.31 |
| B f f | 10 4 | 8 45 |
| C ial b es d bra | 0 46 | 37 11 |
| pin l d d rt bra | 3 64 | 55 85 |
| Ch d | 10 52 | 47 68 |
| Abd m l d | 11 07 | 66 80 |

Force were compound fractures The percenta e of deaths in this group was naturally much lower than in the group with gunshot wounds of the head pinal cord chest and abdomen A critical analysis of thi table will show that it is mainly the men with wounds of the extremities and face who can be sal vaged returned to duty or later to gainful occupation in civil life

## ORGANIZATION OF THE MEDICAL DEPARTMENT OF THE ARMY IN WAR

To understand the military orthopedic problem in war some knowledge of the organization of the Medical Department and the troops they serve together with a simple plan for their evacuation is e sential

**Theater of Operations** —The Theater of Operations is that area occupied by a military force at war Durin World War I it extended from the base seaport in France to the Meuse Argonne The Theater of Operation i subdivided in o a Combat Zone and a Communication Zone The *Comb Zone* is occupied by the military forces in contact with the enemy and s subdivided into army area in which the variou divi ions and the Medical Department installations attached thereto will be found The *Co nn unic tions Zone* in which are organized the service of supply to the fo ward arm es and the general hospital of the Medical Department fo definitive care of war casualties extends in an oversea expedition from the base port to the for rd army area In fact the ea from the home port in the Zone of the Inte io to the base port o er seas forms a part of the Communicati ns Zone

**Medical Personnel.**—A regiment f infantry as well as all other military units in the field has medical troop attached to it At present an infantry egiment has a strength of some 3448 officers and men It con i ts oughly f a headquarters and a headquarte s company a anti tank company and three battalions of fou c mpan s each The attached medical troops are known as a *Reg m ital Med cal D ta hm nt* consistin of eight med cal office s two dental officers and ninety six en

listed men This detachment is organized into a headquarters section and three battalion sections The senior medical officer i known officially as the Surgeon normally holds the rank of major and is on the special staff of the colonel commanding the re iment The regimental surgeon heads the headquarters section and assigns his three senior medical officers as battalion surgeons

Each of the battalion surgeons commands a *Battalion Med ical Section* which renders service to the regimental battalion to which it is attached The infantry battalion is the fighting unit of the regiment Under the direction of the regimental surgeon the battalion surgeon is re ponsible for the health of the troops in the battalion he erves—in camp on the march and in combat—and for rendering first aid to all battle cas ualties and for their proper care and evacuation The regi mental and battalion surgeons must at all times be conversant with the facts of the situation and the intentions of their com mander as their problems are markedly changed in a rapid advance in a break through in a holding operation or in a retreat

The battalion medical section is further divided into three sections Two enlisted men are assigned to each of the four companies in the battalion They proceed with the company to which they are attached into the attack render first aid tag the wounded and follow the company as it advances Then the second or litter bearers section comes forward applies occlu sive dressings splints fractures carries the nonwalking wounded by litter and directs walking wounded back to the battalion aid station

## MANAGEMENT OF ORTHOPEDIC INJURIES IN THE VARIOUS MEDICAL INSTALLATIONS OF THE COMBAT ZONE

Each oldier carrie a fir t aid packet in his belt along with ( gm of ulfanilamide which he is to take by mouth if wounded He i protected by active immunization against tetanus Vac cination agin t tetanus by means of plain tetanus toxoid be came compul ory in the United States Army in July 1941

Force were compound fractures The percentage of deaths in this group was naturally much lower than in the group with gunshot wounds of the head spinal cord che t and abdomen. A critical analysis of thi table will show that it i mainly the men with wound of the extremities and face who can be sal vaged returned to duty or later to gainful occupation in civil life

## ORGANIZATION OF THE MEDICAL DEPARTMENT OF THE ARMY IN WAR

To understand the military orthopedic problem in war ome knowledge of the organization of the Medical Department and the troops they serve together with a simple plan for their evacuation is es ential

**Theater of Operations**—The Theater of Operations is that area occupied by a military force at war Durin World War I it extended from the base eaport in France to the Meuse Argonne The Theater of Operations i subdi ided i to a Combat Zone and a Communication Zone The *Combat Zone* i occupied by the military for e in co tact with the enemy and is subdivided into army area in which the various divisions and the Med cal Department installation attached thereto will be found The *Communications Zone* in which are organized the ervice of supply to the forward armies and the general ho pital of the Medical Departn ent for definiti e care of war ca ualties extend in an over eas exped tion from the ba e po t to the forward army area In fact the ea from the home port in the Zone of the Inter or t the base port over seas forms a part f the Commun cations Zone

**Medical Personnel.**—A re ment of infantry as well as all other milita y unit in the fi ld ha medical troops attached to it At pre ent an infantry r g n ent has a strength of some 3448 officer and n en It on st roughly of a headquarters and a headquarters company an ant tank co pany and three battalio s of four companie each Th attached medical troop are kno n as a *Reg tal M d al Detacl n t* consisting of eight medical officers two de tal offi cers a d ninety six en

At the battalion aid station a litter is prepared with blankets so as to maintain the body heat of the patient The splint is adjusted as indicated and fixed to the litter Hemorrhage is controlled if present Sulfanilamide 6 gm is administered by mouth if it has not already been ingested Administration of

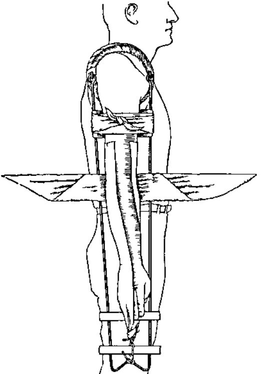
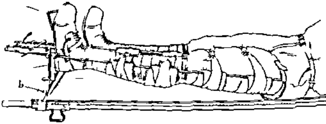


Fig 357—H g 1 t t m pl t t t t t pl t f m m b l t f f i b t th h ld d b f th m d f m bo th m ddl th d Adh pl t sed t bt k t t f f i

sulfanilamide is to be continued in 1 gm doses every four hours during the evacuation of the patient and until discontinued by order Morphine sulfate is administered in ¼ grain doses to relieve pain In the Combat Zone morphine sulfate will be available in solution in a collapsible tube with an at

Troops in tropic America are likewi e immunized a ainst yel low fever

**Litter Bearers Section** —Compound fracture are plinted and the patients are tran ported by the litter bearers section to the battalion aid station Clothin about the wound i cut away the skin adjacent to it is painted with tincture of iod ne which the medical soldier carries in a pecial container and an occlu sive dressing is applied The *army hinged half rin spl t* (modif ed Thomas) is applied to major fractures of lon bones of the lower extremities above the ankles and a *h n ed traction arm splint* to fracture of the upper extremities (Fi 356 and 357) These splints afford fixation traction for tran portation



F g 356 —Imm b l f p t t f p tı t h f l b bo h kl d d f h k ee j ng th Arm h d h lf g pl t (K ll m d fi t f h Th m pl t) Th l g ppo t d th pl b g l b d d pl pport and f h bl b L b h h pl pp rt fi ed (A my Spl t M l)

**Battalion Aid Station** —In a hold n attack the battalion aid station i established from 300 to 800 yard behind th ad a ce lines f the i fantry battalion t er es It located so as to be sheltered f on d ect artille y fire near water if ava lable a d n li e f the natural drift of the walk n wounded The equipment f r e tabl h n the aid station is carr ed by t u k and ns ts ma nly of d e sin banda e dru plint l tte s blankets and tentage The battalion sur geon is respons ble f r the ollection treatme t a d evacuation of the wounded of his battal on t h s battal on aid station and the preparat on f them fo furthe e acuation to the rear

At the battalion aid station a litter is prepared with blankets so as to maintain the body heat of the patient The splint is adjusted as indicated and fixed to the litter Hemorrhage is controlled if present Sulfanilamide 6 gm is administered by mouth if it has not already been ingested Administration of

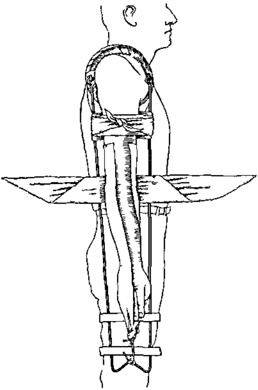
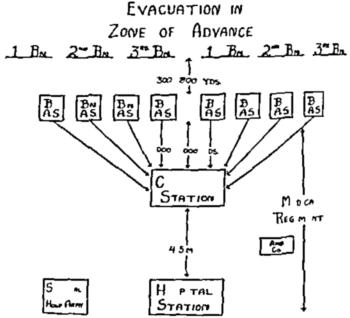


Fig 357 H g d t t pl t t t I t pl t f m m b h t f f t b th h ld d b f th m d f m bo th m d'll th t Adh pl t sed t bt k t t f fi t

sulfanilamide i to be continued in 1 gm do e every four hours during the evacuation of the patient and until discontinued by order Morphine sulfate i administered in grain do e to relieve pain In the Combat Zone morphine sulfate will be available in olution in a collapsible tube with an at




F g 358 — A di mm p se f pl f cuati sse l h th pe bl h l p rt in gi ti n Th *b ation and* se tal f h f t d d f h pl ti g d p p t f t nspo f l es ll f m in f th m l f h t p

Th bs f p t t *t* y t po t t the h mb l se l bl Th d h by personn l l th b t h d tat by h l t se f th ll cting p y

A f rt g l f cat d se f b tl l lik se sse tial H f th first m h k ca be tre t d by intra es

tached sterile needle Sodium amytal has been shown in experimental work on animals by Mann and others to delay the development of shock and it may be well to use it at this time Shock if present is treated by elevation of the foot of the litter and administration of hot drinks caffeine and sedatives

All casualties are tagged The tag gives the name rank and organization of the patient his major wounds where he was wounded (geographically) the time of day and the date on which he was wounded and the medication administered to him No surgery is attempted at this station except first aid A bleeding vessel may be clamped and ligated A tourniquet may be applied if ordered by a medical officer A traumatic amputation may be completed by a snip or two of a pair of scissors and the patient if not in shock prepared for evacuation to the rear

*Evacuation of the Wounded* —Evacuation from the battalion aid station through the collecting station to the hospital or clearing station some 5 miles to the rear is carried out by the elements of the medical regiment in the square division or the medical battalion in the triangular division (Fig 358) When evacuation by ambulance is impossible litter patients are carried by hand or wheel litter and those who can walk are directed by the litter bearers section of the collecting company to the collecting station situated 1000 to 2000 yards to the rear of the battalion aid station

**Collecting Station** —The collecting station is larger and more elaborate than the battalion aid station but its equipment is similar One collectin station will serve three to six battalion aid stations Patients are examined recorded on admi sion

pl m t g bl d pl m sal d gl Th t bl h d by th *h p tal* *l* g *t t* f th d l m d l t p
If pl amb l e is t l bl f f th mm d t trans port t t g l h p tal th C mm t Z g *al h pit l* i th d l *t* *h pital* t th ra l h d ce sary t lesse th t m l g h m t t p rt u sd O ly t th se tal l t ca d b d m t f ds d p m y d q t g l t rve t be t t ted

*R* *4 S* B ttal A 1 St t

checked for shock their dressings are inspected reinforced or changed and tourniquets are loosened and splints readjusted In addition the patients are prepared for evacuation by ambulance to the hospital or clearing station some 4 to 5 miles to the rear

**Clearing Station.**—The hospital or clearing station is located beyond rifle range sheltered from direct artillery fire near a good road leading to the rear far removed from ordnance dumps artillery implacements or other troop concentrations Distance to the rear however cannot protect this installation in total war from aerial bombs which have the same effect as artillery Tentage is pitched to shelter the wounded if buildings are not available Buildings and tentage require camouflage to protect them from air attacks A receiving department or triage is established to examine critically all cases on admission Patients slightly wounded and those fit for duty are returned to their organizations Those in shock are admitted for treatment to the shock section where intravenous replacement normal salt and glucose solution bottled and ready for use will be available along with dried blood plasma Patients whose splints need adjustment or whose wounds require inspection or redressing are admitted to the surgical section Those patients requiring no further care are transferred to the evacuation section fed and cared for there until evacuated by army ambulance or air ambulance either to the evacuation hospital some 10 to 20 miles to the rear or to the general hospital in a Communications Zone

**Surgical Hospital**—Little or no surgery is attempted in the hospital or clearing station unless this station is acting independently far in advance supporting a break through of a mechanized unit or triangular division Head chest abdominal bleeding and nontransportable cases are transferred at once from the triage to the adjacent surgical hospital which has been established in the divisional area by the Army The surgical hospital represents a small section of an evacuation hospital brought forward to the wounded It has full surgical facilities for emergency operative procedure Its personnel may be sup-

plemented by surgical splint and shock teams from general headquarters reserve The belief has been expressed that con sideration should be given to the plan Jolly used in Spain for two years He supplemented the hospital or clearing station with self contained oper iting teams as required the hospital or clearing station became the housekeeping unit providing hospitalization for postoperative cases

**Evacuation Hospital** —The evacuation ho pital ordinarily is established on a railhead since tran portation of wounded to the general hospital in the Communications Zone is by hos pital train and the unit with its equipment i heavy and bulky It has a capacity of 750 beds and is housed in existing build ings or in its own tentage This hospital is completely equipped to give adequate emergency surgery and to afford postoperative care A detailed account of its complete organization and func tion will be omitted The patient with a gunshot fracture arrives here after having been transported by a litter carrier and motor ambulance over various types of terrain under rifle and shell fire and under anything but ideal conditions He arrives on his original litter with his fracture immobilized in the original splint The evacuation hospital corre ponds to the emergency room of the general hospital in civil life Postoper atively after remaining here a few hours to a few days he will be transported again by rail or air to a general hospital for definitive care

The time lag before debridement in the evacuation ho pi tal will depend upon several factors air equality or superior ity availability of road space because supplies ammunition and troops going forward have preference over ambulances re turning type of road weather conditions and the fact that evacuation may be possible only at night

*Ambulances* should be of the four wheel drive type supplied to the infantry Ideally the truck bodies should be made splin ter proof being constructed of some type of thin e pecially hardened steel (armor plate) and the driver should be pro tected by a bullet proof glass wind hield Also ambulances hould be heated

*Management of Patients*—All patients are critically examined on admission to the evacuation ho pital They are classified as follows slightly wounded seriously wounded in shock bleeding case gas ca es medical cases compound fractures and o on Appropriate steps are taken so that indicated treatments may be instituted at once The chief of the surgical service determines the priority of treatment in surgical cases according to the urgency of the case Ca es of hemorrha e and compound fracture are ent at once to surgery unless the patient i in shock Thorough debridement of all wounds is carried out after fluoro copic study to detect the presence of foreign bodies and the nature and extent of fracture Shock cases are treated in shock ward by intravenous replacements with bottled alt and glucose solution dried blood plasma or citrated whole blood

The roentgenologi t reports his findin s by sketchin and in writing to the chief of the surgical team on who e table the patient is placed The pat ent is anesthetized and the splint is removed by the splint team Traction is maintained while the extremity is prepared for surgery *Debridement* is performed that is the skin and fascia immediately surrounding the wound are thoroughly excised the length of the incision is increased both in the k n and fascia so that all traumatized muscles may be exposed and removed large blood ve sel and nerves are avo ded all foreign bodies a e removed as are fragments of bone not attached to the periosteum and those which have lo t their blood supply The wound s thoroughly irri ated with normal salt solut on or Dakin solution and after all es els are l ated several grams of sulfathiazole are sprayed into the wound and it s packed open with gauze soaked in paraffin or with b smuth iodofo m and paraffin gauze (b pp)

If the wound s twelve or more ho rs old and is infected rather than contam nated fore gn bodies are removed and the wound is widely opened to e tabli h d ainage but a true debridement at this time is not considered ad isable

When the su g cal t am has finished its work the splint team reappl es the army hinged half ri g splint To apply it they

use either skeletal traction with a Steinmann pin through the os calcis or skin traction to maintain length and alignment Then the patient is transported in fixed traction to the ward to await further evacuation to a general hospital He is treated until transported

*Primary closure* of wound after debridement was banned by order durin World War I because severe infection often fol lowed it Even with the advantages of the new chemotherapeu tic drugs primary closure is considered hazardous All surgeons agree I think that thorough debridement is indicated but there is considerable disagreement over what should follow this in the handling of compound fractures

*Anticipated Number of Casualties per Day*—The tabulation given earlier shows the percentage and types of wounds to be anticipated so it might be well to consider the number of cas ualties to be expected each twenty four hours from a division that an evacuation hospital supports

The daily percentage of battle casualties in a severe engage ment may be estimated as infantry regiment 12 to 15 per cent infantry divi ion 6 to 8 per cent Army corps 3 per cent The ratio of killed to wounded is 1 to 4 the ratio of killed to wounded and gassed is 1 to 6 Prior to the war of 1914–1918 rifle bullets caused 80 per cent of wound and shell caused 20 per cent In that war this ratio was reversed shells ac counted for 80 per cent of wound rifle and machine gun bullets for 20 per cent Air bombing will increase shell wound casualties It is more accurate to estimate battle casualties in an army on the basis of the number of divisions actually en gaged than to u e a rate ba ed on the casualties of a corps or army Included in the total casualties to be cared for are tho e of the enemy left on the field The battle casualties of a division of 16 000 men having an 8 per cent casualty day may be estimated as follows dead 20 per cent or 256 able to walk to collecting station only 40 per cent or 512 requir ing litter tran portation 40 per cent or 512 (2 per cent of patients nontran portable beyond surgical ho pital 21) total 100 per cent or 1280 Total number to be evacuated by am

bulance to evacuation hospital 1003 (491 of these will be litter patients 512 sitting case ) In World War I more than 2500 patients were received in a twenty four hour period at a certain evacuation hospital

### CLOSED METHOD OF TREATMENT FOR COMPOUND FRACTURES

The closed method of treatment of compound fractures popularized by Trueta in Spain advocated by Orr and first described by Ollier in 1885 has been accepted by many surgeons as ideal both for immediate treatment after debridement and for definitive care

**Spanish War Experience** —Trueta after performin debridement of a wound reduced the fractures by traction a d countertraction He used an orthopedic table packed the wound with plain gauze and applied a skin tight plaster casin He reports 1073 patients were given thi treatment in his hospital In only eight of the e cases did he have to remo e the encasement because of infection and in only one case did gas infection occur He states that approximately 10 000 wounded treated by the closed method survived the retreat from Caledonia and arrived in France He further states that the general consensus of opinion (French surgeons) was that the results were entirely satisfactory and that Arnaud found only one case of gas gangrene in 800 wounded which had been so treated

Arnaud and associates in February and March 1939 observed 2000 of these wounded 600 of whom had been treated by the closed method from fifteen days to six months prior to their observation Patients w th gas infect on naturally would not have survived The surgeon found that soft tis ue wound had healed satisfactorily Fifty per cent of the compound fractures showed mediocre results Malun on and nonunion with overriding of fragments deformitie excessi e callus and multiple eque t a were th rule The be t results were in the upper extremities particularly in the metacarpals All fractures of the femur showed bad results and no wounded joint was

without complicating infection Many fractures showed sup purative dissection of the subcutaneous and subaponeurotic tissues particularly of the thigh and calf with secondary joint involvement or metastatic abscess Such cases showed no clin ical evidence of suppuration such as edema temperature eleva tion or pain but many of the patients appeared to be cachectic and suffered from diarrhea

Arnaud does not advise the systematic use of the closed treatment He is of the opinion that it permits evacuation of the patient in excellent condition for a wounded man without great risk and little pain but that it should not be used in definitive care of compound fractures To quote The difficulties of supervision of the wound under plaster are certain and we can not forget the great suppuration and far reaching arthritis which we have discovered after the removal of the cast and which no revealing symptoms permitted one to suspect

Apparently in certain of these cases the closed method neither prevented infection in the wound after debridement nor did it immobilize the fracture properly Apparently it did pre vent pain and allow patients to become ambulatory and easily transportable

**Fractures Resulting from Air Raids**—In cases of com pound fractures sustained in air raids Matthews sprays the wound liberally with sulfathiazole and sulfanilamide in the proportion of 1 to 3 after surgical excision and immobilization of the limb in plaster of Paris encasement which is cut from end to end and windowed over the wound He acknowledges that the closed method has produced many spectacular suc cesses but does not believe it is the best way in which to treat air raid casualties in big cities because tragedy often occurs when a patient passes from the care of one hospital to another The fracture needs to be constantly and carefully watched Dr Broster Senior Surgeon Charing Cross Hospital London told me himself that he concurs fully in Matthews views

**Contraindications**—Soulie and Linares who advocate the closed treatment believe that immediate employment of the technic at the time of wound excision is contraindicated in the

following conditions (1) if there is a vascular lesion that may cause gangrene (2) if the wound is of such a type that all devitalized tissue cannot be removed (3) if the time la is more than twenty five hours (4) if there i any su picion of the pre ence of gas gangrene (5) if the fracture has not or cannot be reduced except by continued traction (e g open fracture of the shaft of the femur)

Jolly who also recommend the clo ed treatment imme diately following debridement states After application of plaster no case should be evacuated without at least twenty four hours observation in the forward hospital

Gissane is of the opinion that the Thomas splint hould be used in tran portation and that plaster should not be used for immobilization of compound fractures until arrival of the pa tient at a general hospital because when the Orr technic i used there is danger of the development of secondary hemorrha e and gas gangrene The cant German medical literature on the treatment of war wound states that during transportation a modified Thomas splint is used for immobilization of fractures of the lower extremitie

**Closed Method in Osteomyelitis**—The closed treatment i ideal for the treatment of acute metastatic osteomyelitis as well as for the treatment of chronic osteomyelitis or bone abscess following equestrectomy and defacement in those ca es in which there is no loss of continuity of the bone There are no devitalized muscles no open contaminated wounds The ti ues have built up a certain resistance to chronic infections in the same manner as does the peritoneum There are no gas bacilli tetanus spores or virulent foreign streptococci to produce a fulminating cellul ti or gas gangrene The patient i prepared in advance of planned surgery by chemotherapeutic medication and the powdered drug is libe ally sprayed into the wound Bismuth iodoform and paraff n gauze (bipp) i preferred to the vaseline pack as it is by Gu d I have u ed it for the past fif teen years and conside t superior to aseline Liqu d paraffin as a base is less g easy than vaseli e Gau e imp egnated ith liquid paraffin packs into the wou d mo e readily G anula

tions are much more healthy and the wound and dressing do not become odorous as when packed with vaseline Unfortunately bismuth iodoform and paraffin gauze is impervious to x ray

**Fractures of Shafts of Long Bones**—It is not believed that fractures in shafts of long bones can be immobilized in plaster encasements alone even if encasement follows anatomical reduction unless the fracture is transverse Even in the case of transverse fractures angulation frequently occurs regardless of whether the plaster is applied skin tight or padded If a plaster could be made so that the shrinkage in the encasement kept pace with that in the soft tissues of an extremity such a plaster would be ideal

**Problems of Fragment Fixation**—Kennedy Darrah Wilson and Clay Murray insist that fixation of bone fragments must be complete after debridement or their movement will cause infection in a contaminated wound Perfect fixation can not be obtained merely by placement of the limb in plaster encasement Proper length and alignment in fracture of the shaft of a long bone cannot ordinarily be maintained without fixation The fixation may be of the internal type Also fixation may be effected by means of pins thrust through and through respectively above and below the site of fracture The pins are incorporated in the plaster and obviously the fixation is lost when the wound is dressed Roger Anderson dual pins may be used or the Haines system of fixation by pins may be employed Moreover skeletal traction can be exerted through a pin or a Kirschner wire can be incorporated in the encasement Pin fixation is accompanied by dangers of bone infection even when used in the treatment of simple fractures

We are told that plaster encasement is necessary to put the parts at rest to prevent frequent dressings to allow and promote tissue healing and to prevent secondary wound infection Yet when fixation of compound fractures is carried out by the various pin methods the walking casts or metal stirrups are frequently applied and the patient is early made ambulatory Can this be considered rest of the muscles of the extremities or of

the fracture site? The weight is carried throu h the pins inserted into the bone fragments to the plaster encasement Does a surgeon have to apply plaster encasement over a wound to prevent himself from dressing it daily and causin reinfection

Mr Thomas uncle of Sir Robert Jones developed and used his plint with fixed traction to put at rest infected knee and hip joints and promote healing in them The Thomas splint or a modification of it skeletal traction debridement and the dakinization of compound fractures although arduous for the surgeon and painful to the patient was the outstandin contribution to the treatment of gunshot fractures in World War I It will be interesting to ee what method replaces it in the pre ent war The chemotherapeutic drugs undoubtedly will play a leading role in the prevention and control of infection in conjunction with tetanus toxoid

# MANAGEMENT OF FRACTURES IN THE UNITED STATES NAVY


RICHARD H LANING MD FACS

CAPTAIN M ICAL C U ED S AT N Y M CA DIRECT N
N AL H AL P TS t H \

WILLIAM D SMALL MD FACS

C A ER M CA C RP U TE S TES N

AND

CHARLES F FLOWER MD

LIE C AN MED CA C U ITED S ES N


---

THE definitive treatment of fractures occurring among Naval personnel where such treatment is given in our large Naval ho pitals differs little in clinical and technical details from that commonly employed in the best civilian institutions There are however certain problems peculiar to the United States Navy which modify our management of this type of trauma Some of the e problems are occasioned by the occurrence of fractures on board ships by the tran portation of such cases and by the administration of definitive treatment to many on our larger combatant ships and on hospital ships The management of fractures occurring in peacetime with pecial emphasi placed upon the above problems peculiar to the Navy will be di cus ed with the hope that their consideration will prove of general interest and may give pro pective medical officers some under standing of the method employed and thus may prepare them

Th p se ti n t ed b re th pri t es f th h d re n t t be n t ed ff ial fl cti g th new f th Navy Departm t th N al Serv t larg

the fracture site? The weight is carried through the pins inserted into the bone fragments to the plaster enca ement Doe a surgeon have to apply plaster encasement over a wound to prevent himself from dressing it daily and causin reinfection

Mr Thomas uncle of Sir Robert Jones developed and used his splint with fixed traction to put at rest infected knee and hip joints and promote healing in them The Thomas splin or a modification of it skeletal traction debridement and the dakinization of compound fractures although arduous for the surgeon and painful to the patient was the outstandin contribution to the treatment of gunshot fractures in World War I It will be interesting to see what method replaces it in the present war The chemotherapeutic drugs undoubtedly will play a leading role in the prevention and control of infection i conjunction with tetanus toxoid

# MANAGEMENT OF FRACTURES IN THE UNITED STATES NAVY

RICHARD H LANING M D F A C S

CAP A M CA C U ITED S A S N M CA DIRECT N
N L H S P TS II \

WILLIAM D SMALL M D F A C S

C AN ER M ICA CO PS U TE S TES N

AND

CHARLES F FLOWER M D

L C MED CAL C PS U ITED S TES N

---

THE definitive treatment of fractures occurring among Naval per onnel where such treatment is given in our large Naval ho pital differs little in clinical and technical details from that commonly employed in the best civilian institutions There are ho ever certain problems peculiar to the United States Navy which modify our management of this type of trauma Some of the e problems are occa ioned by the occurrence of fractures on board ships by the tran portation of uch cases and by the a lmini tration of def nitive treatment to many on our larger combatant hips and on h pital hips The management of fractures occurring in peacetime ith pecial empha i placed upon the above problems peculiar to the Navy ill be discu ed with the hope that their con ideration will prove of general intere t and may gi e pro pecti e medical offi cer some under standing of the method en ployed an l thu may prepare them

The opi serti t ined here re the privat nes f the th nd re not t strued ial reflect g the iew f the N y Department th N l Service t large

for the care of wartime casualties should this eventuality occur

### INCIDENCE

Tables 1 and 2 give a brief summary of our typical Navy peacetime (1938) fracture incidence

TABLE 1

INCIDENCE OF FRACTURES IN THE U S NAVY (1938)

| | Total | Fractures | Per cent |
|---|---|---|---|
| Admissions to sick list | 54,810 | 2 105 | 3.84 |
| Sick days | 1 160,310 | 81,877 | 7.06 |
| Invalided from service | 1 464 | 47 | 3.21 |
| Deaths | 362 | 3 | 8 84 |

TABLE 2

CLASSIFICATION OF FRACTURES AS TO LOCATION

| | |
|---|---|
| Upper extremity | 1031 |
| Lower extremity | 63 |
| Spine | 66 |
| Thorax | 67 |
| Pelvis | 26 |
| Skull | 75 |

**Increase Due to Naval Expansion.**—Since the statistical report was prepared a great expansion of the Navy has taken place resulting in a marked increase both in numbers and in variety of fractures It is inevitable in such an expansion that rapidly trained and therefore relatively inexperienced personnel handling many types of powerful and high speed machinery will come to grief more frequently than the men whose trauma constituted the figures above Two recent cases aptly illustrate this etiologic element A seaman painting on the catwalk of an aircraft carrier was sitting with his legs hanging over the edge of the catwalk On the deck below a boat crane was being swung into position The seaman s legs were struck by the crane and pinned under the catwalk with resulting extensive fractures of both tibiae and fibulae A young seaman with a number of other men was riding on an open trailer full of stores when in some unexplained manner the trailer broke

loo e from the towing truck The seaman jumped to the road way and sustained a comminuted fracture of the femur The other men who stayed with the trailer were uninjured We may assume that under existing conditions casualties will be large fractures will be numerous our work in their care will be great and every facility for the rehabilitation of these cases must be used to maximum advantage

As regards *causative agents* in the foregoing tables strictly Naval and military hazards accounted for 468 fractures and the remainder 1637 were due to ordinary industrial and mis cellaneous hazards of which motor vehicle accidents constitute a predominant group Although Naval vessels and large shore establishments are actually major industrial units accidents from such cau es have been kept at a creditable minimum by safety precautions and careful training of personnel We can therefore expect a probable relative as well as actual increa e in industrial *accidents and miscellaneous hazards should* while actually much greater maintain approximately the same relative importance as previously

**Modern War at Sea**—It is difficult to make an estimate as to what can be expected should hostilities eventuate Modern naval engagements often last for relatively brief periods a matter of minutes even and when concluded or temporarily stopped can pre ent the medical officers with a staggering prob lem in the care of the wounded Data from recent engagements in the pre ent war however eem to indicate a higher percentage of deaths and a lower percentage of injuries among casualties as compared with previous World War figure Fracture cau ed by penetration of explosive fragments bullets plinter and falls from the force of exploding bombs will naturally con ti tute the major part of increa ed casualties Any e timate of expected ca ualties mu t be ba ed on the experience of others in the pre ent conflict and the figures i ued after major naval engagements have been meager In general however the hip involved in actions of importance during the pre ent war have been those who e *armor protection is relatively light and which* are vulnerable to direct hits by hellfire torpedo and heavy

for the care of wartime casualties should this eventuality occur

## INCIDENCE

Tables 1 and 2 give a brief summary of our typical Navy peacetime (1938) fracture incidence

TABLE 1

I CIDE CE FR CTURES IN THE U S N Y (1938)

| | T tal | Fractures | Per cent |
|---|---|---|---|
| Admis ns t si k list | 54,810 | 2 10 | 3.84 |
| S ck d y | 1 160,310 | 81,8 7 | 7.06 |
| I al ded f m se | 1 464 | 47 | 3 1 |
| De th | 362 | 32 | 8.84 |

TABLE 2

CLAS I CATI FR CT RES AS LOCATI

| | |
|---|---|
| Uppe tremity | 1031 |
| Low tremity | 563 |
| Sp | 66 |
| Th ax | 67 |
| P lvis | 26 |
| Sk ll | 75 |

**Increase Due to Naval Expansion.**—Since thi statistical report was prepared a great expansion of the Navy has taken place resulting in a marked increase both in numbers and in variety of fractures It s inevitable in such an expansion that rapidly trained and therefore relatively inexper enced personnel handling many types of powerful and h h speed machinery will come to grief more frequently than the men who e trauma constituted the figures above Two recent cases aptly illu trate this etiologic element A seaman painting on the cat walk of an aircraft carr er was sittin with his legs hangin over the edge of the catwalk On the deck below a boat crane was be ng swung into p sition The seaman s legs were struck by the crane and pinned under the catwalk with re ulti ex tensive fractures of both tibiae and fibulae A y ung seaman with a number of other men was riding on an open trailer full of stores when in some unexplained manner the trailer broke

*Medical Personnel*—The medical personnel assigned to destroyers usually consists of one medical officer to a division of destroyers (four to six ships) and one hospital corpsman usually a chief or first class petty officer to each ship Smaller craft having medical personnel are provided with one hospital corpsman

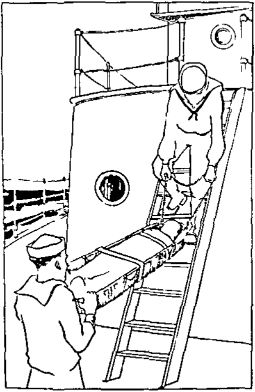


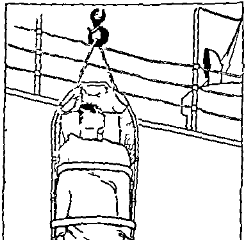
Fig 360—The Stokes stretcher Carrying patient up ship ladder (U S Naval Medical Bulletin)

*Equipment*—This is of necessity meager consisting of a minimum of medicinal substances bandages and other first aid materials a few temporary splints and a *Stokes stretcher* This stretcher is standard in the Navy and has proved well adapted to requirements both afloat and ashore (Figs 359-362) A

bombs Under the e conditions ca ualties can be expected to comprise more deaths and fewer injuries Of the injuries ex tensive compound fractures should con titute a large percenta e

## THE MANAGEMENT OF FRACTURES AT SEA

**Small Ships** —The Navy has an abundant variety of small ships with the destroyer heading the list for size and includin



F g 359—Th S k h H ting p f m narr w sp ce (U S N l Med cal B ll )

submarines mine weepers ub chaser motor torpedo boats and sea going tugs

make disposition of the case If the medical officer is not avail able the *Pharmacist s Mate* arranges to have the patient trans ferred to a larger vessel in the vicinity or to a shore station The pharmacist s mates assigned to such small vessels are well trained capable and competent men usually with ten or more

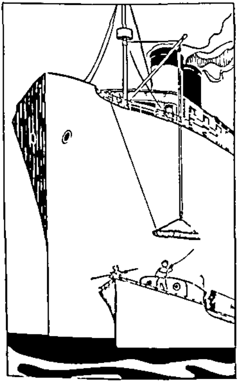


Fig 36 —Th t k t th ll t g patie t bo rd sh p f m m ll bo t (U S N l Med l B ll t )

years of Naval ervice and in the event of inability to transfer the patient to a larger hip or to a shore station can do a very creditable piece of work often di playing marked in enuity in extemporizing gear from uch material as may be available on the hip

**Large Ships.**—In this category may be placed battleships

space called the sick bay is provided on each ship carrying medical personnel but on small vessels it is never adequate for more than the temporary treatment of the sick

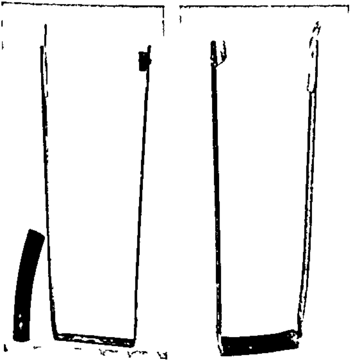
*Management of Fractures*—Should an accident resulting in a fracture occur aboard a small ship the immediate treatment

Fig 361—Th St k t th C y g p t t b d hp ia g y (L S N l M d l B ll )

of the case will consist of immobilizing the injured part in temporary splints using bass wood the ever present Thomas splint or any suitable material found on board ship allaying pain and making the patient comfortable until the division medical officer arrives to determine the exact extent of the injury and

so that the patient is made ambulatory and able to carry on with at least a portion of his duties

Both aboard ship and in our Naval hospitals wide use is made of the *walking iron* cast in the treatment of distal lower extremity fractures Most of these irons are constructed locally and display an interesting variety of construction In the one



F g 363 d 364 —Types f lki g iro

illu trated (Fig 363–365) the hort cross piece on the top of a le bar is ecured by one rivet o that it can be rotated to permit l pping over it a uitable length of old garden hose wh ch when worked over the footpiece makes a handy pringy ki l resi ting and durable rubber cu hion which can be ea ily renewed for u e on another patient On the eve of exten ive

aircraft carriers light and heavy cruisers and the ships of the train such as tenders transports supply ships and repair ships

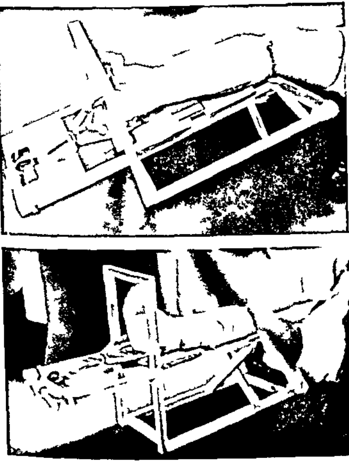
*Medical Personnel*—On these vessels the Medical Department consists of one or more medical officers a dental officer and several (from six to twenty) enlisted men of the Hospital Corps of various ratings Thus there is available a well organized medical unit providing for a division of work and for battle dressing stations located below armored decks which are manned prior to and during an actual engagement

*Equipment*—The equipment of a large ship consists of a *sick bay* which varies in size from six bunks on the older light cruisers to twenty or more on a battleship or aircraft carrier This sick bay is used in peacetime or when engagements at sea are unlikely as is a hospital ward It is equipped with comfortable bunks usually arranged in two tiers and in the newer vessels has one or more surgical type bed secured to the deck Adequate lighting and ventilation are provided together with lockers for bed linen blankets and in enough designed food trays which secure to the bunks and provide the maximum utility in a seaway Storerooms for medicinal agents surgical supplies and splints a small pharmacy and laboratory an operating room with instruments and sterilizers an office and examining room a dental office with full equipment an x ray outfit together with the emergency battle dressing station constitute in general the Medical Department s equipment on board major ships

Under ordinary conditions most of the above mentioned ships can act as independent units as regard the care and treatment of their sick and injured

*Minor Fractures*—When a fracture occurs the patient is transported from any part of the ship to the sick bay Here he is examined and necessary x rays are made Minor fractures involving phalanges metacarpals carpals and distal forearm are reduced under local anesthesia immobilized usually in plaster and the patient is returned to light duty under observation Similarly fractures involving the foot and ankle are reduced immobilized in a plaster boot with a walking iron incorporated

Illustrative of what may be done on board ship is the *leg splint* shown in the accompanying photographs (Figs 366 and 367) which was made on one of the aircraft carriers for the treatment of a fracture of the lower thirds of the tibia and fibula



Figs 366 and 367 — F t mp zed leg pl t m  bo d [illegible] ft carr

Sponge rubber was used for a leg and thigh cradle and at first traction applied by a Kirschner wire through the os calci and attached to a standard stirrup was maintained by weight

maneuvers the Executive Officer of a cruiser sustained a fracture of the distal end of the tibia The fracture was reduced a plaster boot with walking iron applied and on the following day the patient was able to resume his duties much to his satisfaction and to the relief of his Commandin Officer

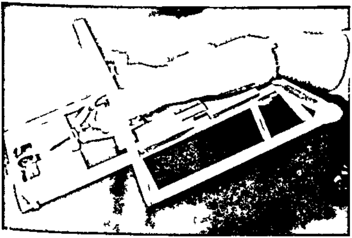
*Major Fractures* —In major fractures occurrin aboard large ships definitive treatment is carried out when nece sary but

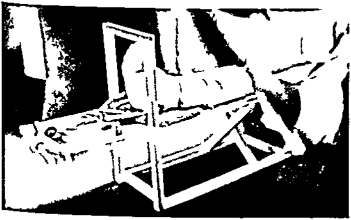
F g 365 —W lk g t

when con alescence is t be protracted the pat ent i usually well prepared fo t an portat on and at the first opportunity evacuated to a hosp tal or hospital ship

*Impro ised Equ pment* —A a large ship s well provided with shops and mecha ical techn c ans many extemporaneously constructed splints and othe apparatus can be manufactured at the suggest on a d under the d ecti n of the med cal officer

Illustrative of what may be done on board ship is the *leg splint* shown in the accompanying photographs (Figs 366 and 367) which was made on one of the aircraft carriers for the treatment of a fracture of the lower thirds of the tibia and fibula





Figs 366 —I mpr ed leg pl t m d I d cr f rrrc

Sponge rubber was used for a leg and thigh cradle and at first traction applied by a Kirschner wire through the os calcis and attached to a standard stirrup was maintained by weight

these latter resting in an upright casing to prevent pendulum action from the motion of the ship at sea Later the weights were discontinued and traction was maintained by an elastic cord the amount of traction being measured by a spring balance After reduction was secured and a cast applied traction in this device was continued to provide a steadying factor against the ship s motion and to promote the comfort of the patient until he could be transferred to a hospital ashore for the completion of his convalescence The variety of such devices and their effectiveness in treating fractures aboard ship is limited only by the ingenuity of the medical officer and his assistants

*First Aid during Engagements* —In wartime since regulations governing watertight and fumetight integrity of compartments are rigidly enforced not only during actual engagement but also during periods when conditions of readiness for action must be maintained the medical department is completely isolated and can render no direct immediate aid to the ship s company during such periods The care of fractures and other casualties durin the above phases is provided for by

1 Careful thorough preparation and instruction of all hands in fundamental first aid measures

2 A competent first aid team to every damage control party which when occasion arises will render aid to the injured in any compartment visited

3 Distribution of first aid kits to all battle stations

*Battle Dressing Stations* —During lulls in battle or when an engagement is finished casualties are promptly collected to battle dressing stations using as stretcher bearers certain members of the crew especially trained for this purpose At these stations treatment and prompt return to duty of the men suffering minor injuries are accomplished Emergency measures of stopping hemorrhage immobilizing fractures allaying pain and treating shock are provided for major injuries Later depending on existing circumstances these patients are given such definitive treatment as is possible or are evacuated to a hospital ship or shore hospital

**Hospital Ships**—There are several types of ships devoted to the care or tran portation of the sick and injured—the fleet

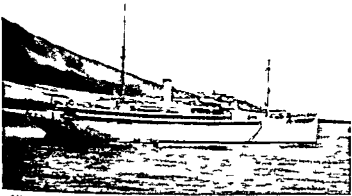
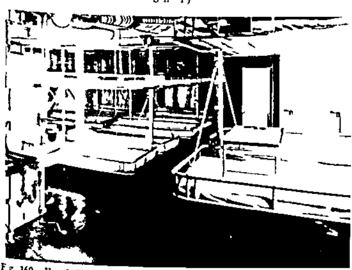
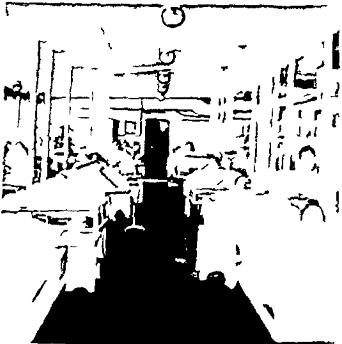


Fig 368—Fl t h pt l h p U S S R h f (C rt y f U S N l M d l S h 1)

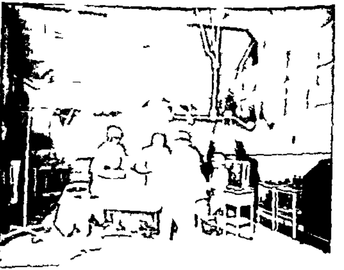


F g 369—W d U S S R l f (C t y f U S N l M d cal S h l)

ho pital ship floating hospital for advanced ba es ho pital tran ports and reserve ships



F 3 0 S rgical wa d U S S R li f (C rt sy f U S N al Medical School )



F 371 M in pe m U S S Reli f (C rtesy f U S N val M dical Sch l )

*Facilities of the Fleet Hospital Ship*—The fleet hospital ship is especially constructed for its intended function which is to accompany the fleet and to provide it with full hospital facilities The size is ordinarily 8 000 to 10 000 tons—large ships are uneconomical—the bed capacity 400 to 500 and the division of

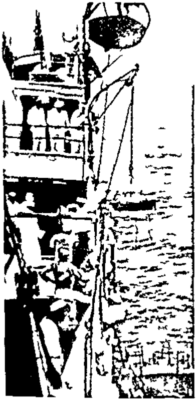


Fig 372—B g g p t t b d U S S R I f t e (C rt y f U S N l M d l B ll t V l 36)

space devoted to hospital use is in accordance with the usual expectancy as regard classification of patients All the usual facilities of a hospital ashore are to be found aboard including a well equipped operating unit a laboratory x ray eye ear nose and throat and dental departments facilities

F 3 0—S gi l ad U S S R h f (C t sy f U S N al Medical S h l)

F 3 1—M m pera m U S S R h f (C rt sy f U S N al M dical School)

*Facilities of the Fleet Hospital Ship* —The fleet hospital ship is especially constructed for its intended function which is to accompany the fleet and to provide it with full hospital facilities The size is ordinarily 8 000 to 10 000 tons—large ships are uneconomical—the bed capacity 400 to 500 and the divi

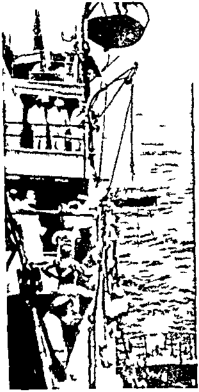


Fig 372—B g g p t t b d U S S R l f t (C t y f U S N l M d l B ll t \ l 36)

sion of space devoted to ho pital use is in accordance with the usual expectancy as regards classification of patients All the usual facilities of a ho pital ashore are to be found aboard including a well equ pped operating unit a laboratory x ray eye ear no e and throat and dental departments facilities

for pecial clinical examinations as well as medical surgical urological and contagious wards For economy of pace on the ship bunks in tead of bed are employed The e are wide com

F 373 —C hng h ing d (C t f U S N val Med cal S b l)

fortable well secured to bulkheads or stanchions and may should need arise be double de ked (F 368–371)

To facilitate l andl n of the si k and injured the ho p tal

ship has wide gangways entry ports in the hull and a plentiful supply of boats and cranes especially designed for hoisting in patients (Figs 372 and 373)

One of our hospital ships the U S S Relief serving a large fleet personnel during a typical year had 202 admissions for fractures classified as given in Table 3

TABLE 3

I cm ce V F ct T p U S S RELIEF urin
PER O YEAR

| | I j d b d Sh p d B ts | I j d in Athl t C t t | I j d by M t V h l | M l l | T t l |
|---|---|---|---|---|---|
| M dibl | 10 | 3 | 7 | 16 | 36 |
| M xill d f ial b | 2 | 1 | 4 | 1 | 8 |
| Cl l | 1 | 4 | 8 | 1 | 14 |
| Scap l | 0 | 0 | 3 | 0 | 3 |
| H m u | 0 | 0 | 5 | 0 | 5 |
| F m | 5 | 0 | 7 | 2 | 14 |
| Wrist | 2 | 2 | 3 | 0 | 7 |
| M ta p l d h d | 21 | 0 | 2 | 0 | 23 |
| Rib | 3 | 2 | 3 | 1 | 9 |
| Sp | 4 | 0 | 4 | 0 | 8 |
| P l | 2 | 0 | 4 | 1 | 7 |
| F m | 1 | 0 | 5 | 0 | 6 |
| P t ll | 1 | 0 | 1 | 0 | 2 |
| T b d fib l | 5 | 0 | 15 | 1 | 21 |
| Ankl | 4 | 5 | 7 | 2 | 18 |
| T | | 0 | 3 | 0 | 7 |
| M t t rsal | 11 | 0 | 3 | 0 | 14 |
| T t l | 77 | 17 | 83 | 25 | 202 |

*Skeletal Traction* —When skeletal traction is employed as it is necessarily at times one problem aboard ship not found ashore is the prevention of pendulum action of the weights This is met by running the cord holding the weights throu h a pipe or tube or by substituting elastic ord for the weights In either ca e the motion of the ship does not then influence the maintenance of teady con tant traction in the desired plane

*Protracted Disal il t es* —While definitive treatment of frac

tures is given aboard ho pital hip and patients for the most part are retained until able to be returned to duty the protracted nature of ome disabilities requires that these latter patients be transferred to ho pital a hore for further conval escence rehabilitation or for separation from the service Whenever the ho pital ship undergoes a navy yard overhaul of necessity all patients must be transferred to a ho pital ashore

*Wartime Functions* —In time of war the functions of the fleet hospital ship can be expected to be con iderably expanded Not only will he provide hospital facilities while vessel re main in port but when the fleet or an expeditionary force goes to establish an advanced ba e she will accompany them When the fleet moves on the hospital ship accompan es the train and leaves behind in field hospital a hore those unable to resume duty in a short time or transfers such patients to hospital tran ports for return to permanent Naval ho pitals

## THE MANAGEMENT OF FRACTURES IN NAVAL HOSPITALS

Our Naval ho pitals are equipped to care for major trauma and fractures of all types the extent and variety of part cular fracture equipment depending omewhat upon the size of the hosp tal The capacity of Naval ho pitals runs all the way from 200 or 300 beds to mo e than 1500

**Convalescent Period** —The management of fractures in these ho pital is like that in m larly equipped civ l nsti tutions but is modified somewhat by circumstances peculiar to Naval requirements and admini tration As the enl ted man has at least theoretically no home or s milar place where he may spend the onvale cent period followin definitive treat ment of his trauma he is retained n the hospital until able to return to his rdi ary duti aboard ship He pends this period performing such work as his condit on perm ts A patient con fined to bed with e e e lowe extremity trauma can fold gauze or a emble sput m cups one with a lower leg fracture am bulant in a walk n t on cast can operate a deck poli hin machine or wa h off bedside locker tops a man with one upper

extremity in a plaster dressing can dust ward furniture or act as a messenger There is a multitude of minor chores that men can do and which serve to occupy their time to useful purpose Later in the rehabilitation stage the early return of function in the injured limb is facilitated by assigning men to carefully elected minor duties and by increasing their activity until they are able to resume their regular work

Men whose trauma results in some permanent residual deformity are not returned to duty as frequently as in civil life As the modern Navy is highly mechanized and intricately organized a man with a stiff elbow for instance returning to a high peed machine is considered not only more liable to further injury to himself but might well be the cause of serious injury to others and at the same time produce a mechanical casualty at a critical moment Such men are usually invalided from the service

**Modern Trends in Treatment**—One of the major trends in fracture treatment in Naval hospitals is toward the wider u e of *ambulatory methods* The reasons for this trend are obvious Another is the increased employment of *local anesthesia* in reduction Elaborate method of anesthesia are usually impracticable and not available aboard ship and in the field A surgeon adept in the use of local anesthesia has a great advantage under such circumstances and as all Naval medical officers do duty at one time or another on ships and under field conditions the place for them to perfect themselves in anesthesia technic is in our hospitals In this connection the use of *intravenous anesthesia* is rapidly widening It is apparently safe and efficient and under service conditions po esses two important characteristics (1) it is nonexplosive and (2) it can be administered with a minimum of sterile equipment

A third notable trend is in the increa ing number of *open reductions* where the fragments are secured by vitallium plates screws or nail In a fracture which cannot be easily reduced and maintained in reduction by ordinary method of traction and manipulation or by one of the more commonly used mechanical reduction devices employing multiple transfixion by

pins or wires early open reduction i done Vitallium has been used by us even in the presence of gross contamination with satisfactory results Most Naval hospitals are equipped with some mechanical reduction device employing pins or wires which are later incorporated in plaster casts In properly selected cases these devices have proved satisfactory and their use is often an important factor in securin an early ambulatory status in fractures of the lower extremity

To our Naval hospitals also come tho e men whose trauma has been of necessity treated el ewhere on board ship or at advanced bases and who sometimes require a revi ion of their previous treatment In ca_es where *malposition* has resulted revision usually consists of open reduction and securin of fra ments by suitable vitallium fixation *No union* formerly treated by bone graft alone is e pecially in cases involvin a major long bon frequently handled by bone graft plu fixation by vitallium

Naval hospitals are al o equipped with effective *physical therapy* installations with trained personnel to administer treatments In the rehabilitation phase of the treatment of major fractures extensive use of physical therapy i routinely made and i considered of value in facilitatin the early return to duty of these pat ents

Medical officers of the Navy afloat and ashore are keenly aware of both the r opportunitie and the r respon ibilities in the care and treatment of fractures and are endeavorin to conscientiously and succe sfully fulfi l the mi sion of their Corp To keep as many men at as many guns as many days a possible

S g ol Cl J \ th Am n
D b 1941

# MANAGEMENT OF WOUNDS

FREDERICK R HOOK MD FACS

C M CAL C RPS U ED S ES N CHIEF S S
U ITED S ES N AL H A WASHIN N DC

THE large number of industrial and traffic accidents that occur in this country has given our surgeons considerable experience in the treatment of contaminated wound The lessons learned from this experience can be applied to the treatment of war wounds if we keep in mind the following facts (1) In modern warfare a large percentage of the wounds are due to bombs *multiple* wounds being extremely common (2) These wounds are associated with severe shock extensive ti sue disruption and early virulent infection (3) High explosive fragments owing to their ragged nature even though small do more damage to the soft tissue than do machine gun bullets and almost invariably carry foreign matter such as pieces of clothing masonry pocket articles and so forth into the ti sues thus favoring infection

There are four general principles that influence the treatment of war wounds (1) the character of the oil on which the fighting takes place (2) the time of the year (3) the type of projectile (4) the character of the military operation

## CLASSIFICATION OF WAR WOUNDS

Many classifications of war wounds have been formulated that of Basil Hughes is descriptive comprehen i e and adequate It is as follows (1) nonpenetrating wounds (2) penetrating (lodging) wound (3) perforatin ound (4) dis

Th p sse ti t d h th rn t l th
t d re t t be trued fi l reflect g th l th
N y Depa tm t th N l Se t l ge

pins or wires early open reduction is done Vitallium has been used by us even in the presence of gross contamination with sati factory results Most Naval hospitals are equipped with some mechanical reduction device employing pins or wires which are later incorporated in plaster cast In properly selected cases the e devices have proved sati factory and their u e is often an important factor in ecurin an early ambula tory status in fractures of the lower extremity

To our Naval hospitals al o come tho e men whose trauma has been of necessity treated el ewhere on board ship or at advanced base and who sometimes require a revi ion of their previou treatment In ca es where *malposition* has resulted re vision usually consi ts of open reduction and securin of fra ments by suitable vitallium fixation *Nonunion* formerly treated by bone graft alone is e pecially in cases involvin a major long bone frequently handled by bone graft plus fixation by vitall um

Naval ho pital are al o equipped with effective *physical therapy* installations with trained personnel to admini ter treatments In the rehabilitation phase of the treatment of ma jor fractures extensive use of physical therapy is routinely made and s considered of value in facilitatin the early return to duty of these patients

Medical officers of the Navy afloat and ashore are keenly aware of both their opportunitie and their re po sibilities in the care and treatment of fractures and are endeavorin to con scientiously and succe sfully fullfil the miss on of their Corps To keep as many men at as many guns as many days as pos sible

tive treatment This may not be necessary however in bullet wounds with small entrances and exits without swelling of the intervening tissues and in multiple superficial wounds due to peppering with tiny fragments of low velocity such as those from hand grenades Bomb fragments do not fall under this category as they have a high velocity and although they frequently do produce peppering of the surface tissues small fragments may produce severe damage by penetrating the deeper structures

*Gutter wounds* are the easiest type to excise for the entire track is under vision *Penetrating wounds* contain foreign bodies includin bits of clothing blood clots and so forth these must be taken away with the wall of the track and to make this possible adequate exposure is essential Every crevice must be explored and all hematomas opened up *Perforating wounds* of the tunnel variety of approximately the same dimensions throu hout their length may be handled by tubular excision If the deeper parts of the wound are of greater dimensions than those nearer the surface excision of the track becomes more difficult It is important not to cause additional trauma and intact skin and muscle should not be ruthlessly divided in order to join wounds of entrance and exit

**Preparation for Operation** —Routine wound excision under battle conditions requires a maximum amount of team work Although it is highly desirable that these patients reach the operating theater at the earliest possible time they should not be transported until shock has been brou ht under control and until *x* ray examination has been made of wounds in which foreign bodies are lodged The selection and preparation of cases for operation will usually have to be done by someone other than the surgeon and each surgical team to conserve time should have two operating tables Many victims of head neck and trunk wound die before reaching the hospital Because of this fact about two thirds of the wounds of tho e patients arriving at hospital alive are located in the extremities An orthopedic type of operating table therefore is desirable since it gives support to the limb during operation

ruptive (blast) wounds (5) incised and stab wounds (6) burns (7) asphyxiation and gas poisoning (8) accidental wounds

## CHANGES OCCURRING IN WOUNDED TISSUE

Hughes describes three changes that occur in wounded tissue These are (1) di ruption (2) reactionary edema and (3) visible infection The amount of disruption depend upon the velocity of the missile and is at its greatest in penetratin or lodging wounds Disruption of mu cles results in their fasciculi being forced apart and deprived of their blood supply it frequently extend over a considerable di tance from the wound and the tissues so affected make an excellent medium for anaerobic infection Reactionary edema soon follows disruption There is outpouring of lymph into the spaces formed in the di rupted ti sue so that the parts swell In the ca e of di rupted muscles of a limb tension beneath the deep fa cia may become so great as to jeopardize the circulation The ti sues at thi time are contaminated but as yet not vi ibly infected The interval bet veen contamination and the appearance of e idences of infection is commonly known as the time la In a matter of hours the stage of reactionary edema pas es imperceptibly into that of vi ible infection The s elling increases to such an extent that frequently edematous muscle vill be seen protruding from the wound This protrusion produces a stopper effect in an opening hi h is inadequate already and further in pede the e cape of inflammatory products

## EXCISION OF WOUNDS

**Principles of Wound Excision** —A w und i co isidered recent from t ception until sign f inflamm tion devel p these u u lly appea with n t venty four hour The princ ple of ound e cision demand that (1) pe tive treatment be instituted befo e ev dence f i flammation appears (2) the tissues lining the wound t ack be dequately excised and (3) immobili at on of the inju ed pa t be ma nta ned in order to give complete rest

The great majority of p ojectile v ound v ll requ e opera

tive treatment This may not be necessary however in bullet wounds with small entrances and exits without swelling of the intervening tissues and in multiple superficial wounds due to peppering with tiny fragments of low velocity such as those from hand grenades Bomb fragments do not fall under this category as they have a high velocity and although they frequently do produce peppering of the surface tissues small fragments may produce severe damage by penetrating the deeper structures

*Gutter wounds* are the easiest type to excise for the entire track is under vision *Penetrating wounds* contain foreign bodies including bits of clothing blood clots and so forth these must be taken away with the wall of the track and to make this possible adequate exposure is essential Every crevice must be explored and all hematomas opened up *Perforating wounds* of the tunnel variety of approximately the same dimensions throughout their length may be handled by tubular excision If the deeper parts of the wound are of greater dimensions than those nearer the surface excision of the track becomes more difficult It is important not to cause additional trauma and intact skin and muscle should not be ruthlessly divided in order to join wounds of entrance and exit

**Preparation for Operation**—Routine wound excision under battle conditions requires a maximum amount of team work Although it is highly desirable that these patients reach the operating theater at the earliest possible time they should not be transported until shock has been brought under control and until x ray exam nation has been made of wounds in which foreign bodies are lodged The election and preparation of ca es for operation will usually have to be done by someone other than the surgeon and each surgical team to conserve time hould have two operating tables Many victims of head neck and trunk wounds die before reaching the hospital Because of thi fact about two thirds of the ounds of tho e patients ar riving at ho p tal ali e are located in the extremities An orthopedic type of operating table therefore is desirable since it give upport to the limb during operation

These patients who have wounds in the limbs do not stand surgery well and any procedure attempted should be accomplished as expeditiously as possible With this fact in mind it may be necessary for the surgeon to treat only the most serious of a patient s wound and at times a rapid *amputation* may be a life saving measure in cases in which a prolonged operation might be more than the patient could survive Ordinarily the only indication for amputation is a destruction of the blood supply to the limb occasionally however it will be necessary to do an emergency amputation of a limb caught in machinery or under fallen masonry *Tourniquets* should not be used except when amputations are being done and it is necessary to control rapid loss of blood Statistics show that 80 per cent of limbs on which tourniquets have been applied for three hours have come to amputation Jolly states that there are more limbs and lives lost at the front from the improper use of the tourniquet than are saved by its proper use

**Technic of Wound Excision.**—The skin must be prepared well above and below the wound and around the entire circumference of the limb This preparation may be made in the usual manner by the use of ether iodine and alcohol or any of the other commonly used skin antiseptics or it may be made by scrubbing with large amounts of tincture of green soap and water The wound itself should be protected from further contamination during this procedure Bisgard and Baker protect it by temporarily closing the wound with Michel clips They have shown by animal experimentation that tincture of green soap washings in wound definitely delays wound healing After the skin has been prepared the skin edges of the wound are excised care being taken not to sacrifice any more of the skin than is absolutely necessary Adequate longitudinal incisions should be made so that every part of the wound comes under direct vision without marked retraction of the tissues The wall of the track should be picked up with toothed forceps and complete excision of the track done with a sharp knife Injury to important vessels and nerves should be avoided Foreign

bodies should not be removed through separate incisions but should be reached by following the wound track

Aponeurosis tendon and bone are resistant to the invasion of bacteria and can survive in spite of a poor blood supply It is desirable to remove completely detached fragments of bone but if there are any attachments to periosteum it is advisable to leave them particularly if they are needed to provide con tinuity of bone

*Damaged Muscle Tissue* —Much of the surgeon s time will be taken up by the attention he must give to the damaged muscle tissue If the muscle bleeds on section it is safe to leave If it is brick red in color and does not bleed easily or contract when pinched anaerobic infection is present and the whole muscle or group of muscles may have to be sacrificed If the muscle s blood supply has been destroyed above and below the wound the muscle must be removed up to its attach ment to bone or tendon in order to prevent necrosis and infec tion When a muscle is completely divided the portions retract They must be followed up and the damaged tissue removed from them even though marked enlargement of the wound is necessitated Nerves that are severed should be brought into apposition if this can be done without tension otherwise they should be left for another occasion Meticulous hemostasis is important Individual vessels should be ligated with fine catgut sutures with as little tissue as possible included in the ligature

## MANAGEMENT OF WOUNDS AFTER EXCISION

What shall we do with the wound after excision has been completed? The two great principles which have emerged from the modern treatment of wounds by excision are (1) tissue support is needed to prevent or control edema and (2) im mobilization is needed to give complete rest to the injured part If the surgeon will observe these principles he will not be con fused by the diversity of methods that have been described for handling of wounds after excision has been completed

**Primary Suture** —There is ample evidence that primary suture is a safe and correct procedure in civil practice In war

These patients who have wounds in the limbs do not stand surgery well and any procedure attempted should be accomplished as expeditiously as possible With this fact in mind it may be necessary for the surgeon to treat only the most serious of a patient s wounds and at times a rapid *amputation* may be a life saving measure in cases in which a prolon ed operation might be more than the patient could survive Ordinarily the only indication for amputation is a destruction of the blood supply to the limb occasionally however it will be necessary to do an emergency amputation of a limb cau ht in machinery or under fallen masonry *Tourniquets* should not be used except when amputations are being done and it is necessary to control rapid loss of blood Statistics show that 80 per cent of limbs on which tourniquets have been applied for three hours have come to amputation Jolly states that there are more limbs and li es lost at the front from the improper use of the tourniquet than are saved by its proper use

**Technic of Wound Excision.**—The skin must be prepared well above and below the wound and around the entire circumference of the limb Thi preparation may be made in the usual manner by the use of ether iodine and alcohol or any of the other commonly used skin antiseptics or it may be made by scrubbing with large amounts of tincture of green soap and water The wound itself should be protected from further contaminat on during th s procedure Bisgard and Baker prote t it by temporarily closing the wound with Michel cl ps They have shown by animal experimentation that tincture of green soap ashi gs in wound definitely delays wound healing After the sk n has been p epared the skin edges of the wound are ex c sed care bei g taken not to sac fice a y more of the skin than is absolutely necessary Adequate long tudinal incis on should be made so that every part of the wound comes under direct vision without marked ret action of the tissues The wall of the track should be picked up with t othed forceps and complete exc sion of the track d ne with a sharp kn fe Injury to important vessels and nerves should be avo ded Forei n

bodies should not be removed through separate incisions but should be reached by following the wound track

Aponeurosis tendon and bone are resistant to the invasion of bacteria and can survive in spite of a poor blood supply It is desirable to remove completely detached fragments of bone but if there are any attachments to periosteum it is advisable to leave them particularly if they are needed to provide con tinuity of bone

*Damaged Muscle Tissue*—Much of the surgeon s time will be taken up by the attention he must give to the damaged muscle tissue If the muscle bleeds on section it is safe to leave If it is brick red in color and does not bleed easily or contract when pinched anaerobic infection is present and the whole muscle or group of muscles may have to be sacrificed If the muscle s blood supply has been destroyed above and below the wound the muscle must be removed up to its attach ment to bone or tendon in order to prevent necro is and infec tion When a muscle is completely divided the portions retract They must be followed up and the damaged tissue removed from them even though marked enlargement of the wound is necessitated Nerves that are severed should be brought into apposition if this can be done without tension otherwise they should be left for another occasion Meticulous hemostasis is important Individual vessels should be ligated with fine catgut sutures with as little tissue as possible included in the ligature

## MANAGEMENT OF WOUNDS AFTER EXCISION

What shall we do with the wound after excision has been completed? The two great principles which have emerged from the modern treatment of wound by excision are (1) tissue support is needed to prevent or control edema and (2) im mobilization is needed to give complete rest to the injured part If the surgeon will observe these principles he will not be con fused by the diversity of methods that have been described for handling of wounds after excision has been completed

**Primary Suture**—There is ample evidence that primary suture i a safe and correct procedure in civil practice In war

surgery it is probably safe if the exci ion has been performed early is complete and aseptic If the wound is sutured four conditions must be met (1) there must be no buried sutures put in the wound to close dead spaces (2) the skin edges mu t close without tension (3) drainage tubes must not be left in the wound and (4) the patient must remain under the care of the surgeon doing the work What has just been said does not apply to war wounds of the hand face calp thorax and abdominal cavity as according to routine they are closed by primary suture

**Packing the Wound**—Packing the wound gives excellent support to the ti sues from within as the pack replaces the bulk of ti sue removed This packing may be done with dry gauze (Trueta) va eline gauze (Orr) or with cod liver oil gauze (Odelberg) Gurd and McKim report excellent re ults when the wound is packed with bismuth iodoform and paraffin paste (bipp) It is important that every crevice of the wound be packed if the best results are to be had

**Closed Plaster Method of Treatment**—The clo ed pla ter method of treatment was popularized by Trueta in the recent Spani h war It is based upon the Orr method of treatment of o teomyelitis and the Bohler treatment of fractures After thorough wound exci ion either followed by primary suture or wound packing an accurately molded plaster case applied to the sk n with padding only over the bony promin nces The case must mmobilize the jo nts abo e and below the injury it must neve be padded and wi dows nust never be cut in it s nce edema w ll occur at the s te of the cut-out and defeat the purpose of the treatment Changes n the plaster should be made only when it becomes soft or offensive as some toxemia develops with each change Every two to five weeks usually is sufficient It is important that elevation of the pa t be main ta ned in the cl sed plaste treatment s nce elevation tend to diminish the edema and preserve the circulation To insure the safety of this metl od of t eatment wound exc sion must be complete and it must be carried out within si to eight hours after injury The blood sup ply of the limb must not be in doubt

Trueta reported a surprisingly small number of cases of strep tococcal septicemia and gas gangrene from this method of treatment British surgeons also have used the method with gratifying results but are of the opinion that it is still on trial

**Carrel Dakin Treatment**—The Carrel Dakin treatment may be advisable in those cases in which wound excision has been incomplete This treatment fails to provide both tissue support and appropriate immobilization of the injured part but has the advantage of encouraging wound drainage It may be used when it is known that dead tissue will have to separate It has the disadvantage of requiring a maximal amount of supervision if it is to be successful In the present war it will probably be a method of treatment of necessity rather than of choice as was the case during the latter part of World War I

## INTERNAL FIXATION OF FRACTURES

About 60 per cent of all war wounds are compound fractures For this reason every surgeon caring for war wounds should have a good working knowledge of the management of frac tures By meticulous wound excision many of our surgeons in civil practice have been able to use internal fixation in com pound contaminated fractures with excellent results Undoubt edly they could use it successfully in selected war wounds The question is however would it be advisable to recommend it for general use? The answer at the present time must be no

If the immobilization afforded by a nonpadded casing is not satisfactory skeletal traction may be used by the insertion of pins above and below the fracture They are embedded in the plaster or attached to the lateral bars of a Thomas splint Better still are the methods of Haines and of Roger Anderson in which dual screws or half pins inserted into the bone above and below the fracture site are made to hold the fragments in alignment by a rigid external bar This bar not only gives firm fixation but allows the application of plaster to the skin thereby giving support to the tissues These methods of treat ment make it possible to change the casing without disturbing the position of the fracture They would appear to have their

greatest application in patients in whom there has been marked comminution of bone accompanied by loss of substance as they will prevent shortenin, of the member and malposition of the fragments durin the long healin period

## INFECTED WOUNDS

Unfortunately battle conditions are such that many wound are not seen by a surgeon competent or equipped to carry out the correct definitive treatment until visible infection is established During the period of contamination organisms multiply in the tissues but invasion of the lymphatics does not yet occur It is during this period that excision can be done with safety Thi period may be as long as twelve hours but it i possible that the hemolytic streptococcus may pass beyond the barrier within six hours The clinical appearance of the patient and the circumstance of the wound must be the deciding factor in determining period of safety of excision

As infection succeeds contamination micro-organi ms have extended beyond the wound track toxins are bein ab orbed and the patient becomes ill Wound excision at this time not only will be u ele s but will be a dangerous procedure Many of the patients seen in this co dition will be treated by wound dressing Any active surgical intervention must be purposeful and well planned Indications may arise that call for incision for drainage removal of foreign bodies or the control of secondary hemorrhage To prevent breaking down of the natural barriers accompanied by release of toxins and organisms into the circulation extreme gentleness should be observed in handling the limb

**Clinical Signs of Infection** —By the second or third day definite signs of inflammation will be present Many of the patients will have suffe ed for hours or days from hunger pain and expo ure when seen at th s time unless there is definite evidence of anaerob c infection it nay be best to allow them food rest and sleep before decision on any surgical procedure is made This period of observation and rest will not only put the patients in better cond tion to withstand surgery but it will

make surgery unnecessary in some of them If when seen late the patient is comparatively comfortable and there is little edema or tenderness along the track of the missile or no dis charge from the depth of the wound the wound should be let alone If there is tenderness along the wound track or about the wound the surgeon should be suspicious of deep infection Radiographs should be made to show whether foreign body and gas bubbles are present Pain and a sense of tension in the limb while at rest are distinct danger signals frequently pointing to anaerobic infection Increase in pain and swelling two or three days after a severe bruise wound may mean a deep seated in fection of extravasated blood A thin offensive bloody discharge and a spreadin mottled bronzing discoloration of the surround in skin are indicative of anaerobic infection and debridement must be done A rising pulse rate with pain in and about the wound a subnormal temperature or a sudden rise to 103 or 104 F are danger signals that point toward gas gangrene in fection

**Wounds Containing Debris**—In penetrating wound where a large jagged missile has probably carried bits of clothing and other debris into the wound $x$ ray localization and immediate removal are indicated This removal is accomplished by free incision in longitudinal directions when possible debridement (not excision) as well as careful and gentle ex amination of all parts of the wound If the fragment is found in damaged muscle this muscle should be excised because of the probable development of gas gangrene The wound should have free and easy drainage from all parts

**Wounds Complicated by Fractures**—The dangers of epsis are much greater in wounds that are complicated by

W h tl t m d b d m t d w d is f q tly sed t rch g bl A d g t some th t this t t as th t rm dcb i m t h tri tly tra l t d m th g m th l g m t f th d This p d w fi t i sc bed by Desa lt 1789 P D l d his c k rs in Fl d d ri g W ld W I d l ped wh t is w k n w d Th t t m t y ym d th l d caf f th se t ly diff t W d pe miss bl ly in ly t m t d w d h l d brid m t h t fi ld f sef l ess i th lat f ted d

fractures of long bones There is frequently marked disruption of the soft tissues by the bone fragments Such cases will al most always require debridement Free incision must be made to explore the depth of the wound foreign bodies includin the pieces of bone must be removed If there is alteration of the color or consistency of the muscle or if it fails to bleed when cut it must be cut away until normal muscle is encountered Gas gangrene is primarily a disease of disturbed circulation If gas gangrene i already established it may be nece sary to ex ci e the entire muscle or group of muscles After bleedin has been controlled and free drainage establi hed to every cre ice of the wound it may then be packed with vaseline gauze and a nonpadded plaster casing applied The Haines and the Roger Anderson methods of plinting are especially indicated in this type of fracture as they give better immobilization than other method and they permit chan ing of the casin and dressin of the wound without disarran ement of the fracture alignment

In general the followin rules hold true in the treatment of infected fractures (1) Dressings should be applied as infre quently as possible (2) Strong chemical antiseptics are def initely harmful and inte fere with vound healin Dak n s solution probably has its greatest use in deep infected wound in which debrideme t has been done (3) The closed plaster method achieves complete rest for the limb it prevents inter ference with the wound and it pe mit free escape of pus and ecretions

**Serums** —Until our troop are actively immunized a ainst tetanus with tetanus toxoid it will be nece sary to u e prophy lactic doses of tetanus antitoxin n the presence of all var wound Surgeons w rki g in the last war f und it advi able to repeat th inject o n the severely wound d and followin surgery at later dates P ophylactic do es of a ti gas gangrene serum should be used n all wounds n wh ch there has been considerable mu cle damage th s is especially true for wound of the lower extremitie and th buttocks Anti gas gangrene serum hould also be gi en as a urati e measure after the di ease is established

**Radiation Therapy**—As to the value of radiation therapy in the treatment of gas gangrene infection there is considerable difference of opinion Kelly has reported excellent results with its use while Caldwell feels that it is of no particular value

## CHEMOTHERAPY IN WAR WOUNDS

It is too early at this time to prophesy just what place the sulfa drugs will eventually occupy in the treatment of war wounds With the many excellent papers being published on the treatment of contaminated wounds in civil practice with these drugs and the large amount of animal experimentation that has been done both in this country and abroad on simulated war wounds it is believed that the following conclusions are warranted

1 The *sulfonamides* have opened up an entirely new approach to the treatment of war wounds

2 Although they show promise in the treatment of established infection their greatest use will probably be in the prevention or lessening of intensity of infection If they do nothing more than prolong the period in which wound excision can be done with safety they will prove to be of inestimable value

3 *Local application* of the drugs is superior to their use orally since 75 to 100 times the concentration can be had in the tissue about the wound as can be produced by oral administration No safe dose by mouth can give as high a local concentration as a moderate sized dose locally

4 In a powdered form these drugs used locally are bacteriostatic and bacteriocidal (at least for some micro organisms) They produce little tissue reaction and unless used in excessive quantities interfere very little with wound healing The average dose in a wound should be about 0 1 gm per square inch of wound surface

5 *Sulfanilamide* is rapidly absorbed from the peritoneum (Jackson) the blood concentration peak occurring between the second and third hour after implantation It takes twenty four hours to get the peak concentration when administered

fractures of long bones There is frequently marked disruption of the soft ti sues by the bone fragments Such cases will al most always require debridement Free inci ion must be made to explore the depth of the wound foreign bodies includin the pieces of bone must be removed If there i alteration of the color or consistency of the muscle or if it fails to bleed when cut it must be cut away until normal muscle is encountered Gas gangrene is primarily a disea_e of disturbed circulation If gas gangrene is already established it may be necessary to ex ci e the entire muscle or group of muscles After bleedin has been controlled and free drainage establi hed to every crevice of the wound it may then be packed with va eline gauze and a nonpadded plaster casing applied The Haines and the Ro er Anderson method of splintin are especially indicated in this type of fracture a they give better immobilization than other method and they permit changin of the casin and dressin of the wound without disarrangement of the fracture ali nment

In general the following rule hold true in the treatment of infected fractures (1) Dressin s should be applied as infre quently as possible (2) Strong chemical antiseptics are def initely harmful and interfere with wound healin Dakin s olution probably has its greatest use in deep infected wound in which debridement has been done (3) The closed plaster method achieves complete rest for the limb it prevents inter ference with the wound and it permits free escape of pu and ecretions

**Serums** —Until our troops are actively immunized against tetanus with tetanus toxo d it w ll be nece sary to u e prophy lactic doses of tetanus ant toxin in the p esence of all ar wound Surgeons worki g in the last war found it advisable to repeat the i jection in the severely w unded and followi surgery at later dates P ophylact c do es of anti gas gangrene seru n should be used in all wounds in which th re has been considerable muscle damage thi s especially true for wound of the lo er extremitie and the buttocks Ant gas gangrene serum should also be given a a cu ative measure after the di ea e s establi hed

ment from the air The mortality rate of burns varies with the areas of the body burned and it is the surface extent of the burn rather than its depth that endangers life A burn covering more then a quarter of the body surface is always a serious threat to life In the past the mistake has been made frequently of neglecting the patient s general condition while treating the local lesion This error has resulted in the development of a state of irreversible shock

**Pathology** —Deaths from burns fall under four categories

1 *Primary Shock* —Primary shock accounts for only 2 to 3 per cent of burn deaths It occurs shortly after the injury and is somewhat similar to a syncopal attack It may be based on a psycholo ical factor and is usually seen in patients who have been rescued from burning buildings It responds readily to re lief from pain warmth reassurance and similar measures

2 *Secondary Shock* —Secondary shock accounts for 60 to 80 per cent of deaths from burns It develops rapidly being manifest within two hours after injury There is still consider able dispute about the pathological physiology that brings about burn shock There seems to be little doubt that the fluid imb ilance seen in severe burns is due primarily to an altered capillary permeability with a shift of the fluid protein into the ti sues rather than an external loss A burn of one sixth of the body surface may result in the loss of over 70 per cent of the total volume Associated with this loss is marked hemoconcen tration

3 *Toxemia* —Toxemia occurs from two to ten days after the injury It is caused by flooding of the liver with toxins absorbed from the damaged tissue cells and from septic absorption from the wound Adequate amounts of glucose should be given to protect the liver

4 *Scarring* —Scarring occurs as a rule only in the deep burns and is preventable primarily by proper care of the wound and by early grafting of skin

**Treatment** —Three objectives should be kept in mind in the treatment of burns (1) prevention and control of shock (2)

orally The dose *intraperitoneally* should be about 175 m per kilogram of body weight and should never exceed 12 to 15 gm

6 As a prophylactic agent sulfanilamide should be used locally and orally in all contaminated wounds The primary oral dose should be twice the maintenance dose

7 After infection is established and e pecially if staphylococci and anaerobes are found in the wound *sulfathia ole* should be used locally and orally or the two drugs may be used together A study of the bacteriology of the wound will help the surgeon to outline the treatment

8 Because of vomiting or following wound or operations on the gastro intestinal tract ulfanilamide may be given *by hypodermoclysis* in 0 8 per cent concentration in normal saline solution If it is given intravenously in the soluble salts a blood concentration peak can be reached within five minutes

9 Sulfanilamide powder and tablet will probably be i ued to our troops for local and oral use *mmediately after inju y* The swallowing of a few tablets will be a simple matter but the way in which the wounded man will get the powdered dru down into the depth of a perforating or penetrating wound when the wounds of entrance and exit are mall i another problem

10 The early reports on *sulfad a ine* (Long Strauss and Peterson and Feinstone and associates) lead to the opinion that this new compound is superior to the other sulfa drugs in that it is less toxic adequate blood concentration can be main tained with more ease than with the others and it has greater activity than they do a ainst the streptococci staphylococci Escherichia coli Clostrid um welchii and Cl septique

11 *Zinc pe oxide* may be of use in the treatment of anaerobic infections

12 Chemotherapy is not a substitute for adequate surgery it is a valuable adjunct

## BURNS

In the present war burns const tute a h gh percentage of the casualties seen not only in service pe sonnel but also in civilian populations This fact is due to the great increase in bombard

ment from the air The mortality rate of burns varies with the areas of the body burned and it is the surface extent of the burn rather than its depth that endangers life A burn covering more then a quarter of the body surface is always a serious threat to life In the past the mistake has been made frequently of neglecting the patient s general condition while treating the local lesion This error has resulted in the development of a state of irreversible shock

**Pathology** —Deaths from burns fall under four categories

1 *Primary Shock* —Primary shock accounts for only 2 to 3 per cent of burn deaths It occurs shortly after the injury and is somewhat similar to a syncopal attack It may be based on a psychological factor and is usually seen in patients who have been rescued from burning buildings It re ponds readily to re lief from pain warmth reassurance and similar measures

2 *Secondary Shock* —Secondary shock accounts for 60 to 80 per cent of deaths from burns It develops rapidly being manifest within two hours after injury There is still consider able dispute about the pathological physiology that brings about burn shock There seems to be little doubt that the fluid imbalance seen in severe burns is due primarily to an altered capillary permeability with a shift of the fluid protein into the tissues rather than an external loss A burn of one sixth of the body surface may result in the loss of over 70 per cent of the total volume Associated with this loss is marked hemoconcen tration

3 *Toxemia* —Toxemia occurs from two to ten days after the injury It is caused by flooding of the liver with toxins absorbed from the damaged tissue cells and from septic absorption from the wound Adequate amounts of glucose should be given to protect the liver

4 *Scarring* —Scarring occurs as a rule only in the deep burns and is preventable primarily by proper care of the wound and by early grafting of skin

**Treatment** —Three objectives should be kept in mind in the treatment of burns (1) prevention and control of shock (2)

prevention of acute toxemia and sepsis and (3) prevention of scarring

*Burn Shock* —In all burns of any consequence prophylaxis of shock should be instituted when the patient i first seen unfortunately many patients will be in severe shock by the time they reach the hospital Morphine 1/ grain should be given to control pain clothes hould be cut away and art ncal heat applied In management of the flu d replacement Lee Rhoads and Wolff have found that consecutive determinations of the hematocrit and plasma concentration in patients with extensive burns make it possible to estimate the probable los of protein from the circulating plasma and to evaluate the ability of the vascular tree to retain added plasma at variou times following the injury This abnormal capillary permeabil ity continues for about forty hours By the u e of adrenal cortical hormone they have been able to shorten this period by twelve to eighteen hours By means of a combination of *ad enal cortical lormone* and frequent or continuous *plasma infusions* under rigid laboratory control they have carried patients with as much as 65 per cent of the body surface burned throu h the pe iod of fluid shift Oxygen administered by the Boothby mask i of value also

*Toxemia a d Sepsis* —Toxemia and sepsis should be pre vented by *p oper cleans ng* of the burned area and by *early coagulation* The wound sl ould be ponged gently with saline solution it may be necessary to u e ether or ether soap to re move grease Blistered and loose skin should be cut away This work should be done under general anesthe ia pentothal so dium be g an ideal age t The surface may then be coagulated with triple dye (gentian v olet 1 400 brilliant green 1 400 flavine 1 1000) or tann ng n ay be produ ed by tannic acid (5 per cent) alone or in combination with silver nitrate (10 per cent) There are st ong advocates for each of the e meth od under war conditions wl en the time element is of great importance the tannic acid silver nitrate treatment has the advantage that it produces a good protective coa ulum within a few m nutes if tannic acid is pray d on and silver nitrate

is then swabbed over the surface If there is an associated soft tissue wound or fracture of the extremity plaster may be applied over the tanned area with safety and comfort to the patient

Warning has come from England with regard to the use of tannic acid on burns of the *face* and *hands* If it is used on the face the eyes must be protected When it is used on the hands in deep burns the coagulum may contract to such an extent as to cut off the blood supply to the ends of the fingers and gangrene of the terminal phalanges results On the face and hands flavine 1 1000 in cod liver oil continuous hot saline packs or an aqueous solution of 1 per cent gentian violet may be used

Early *skin grafting* is necessary to prevent scarring from deep burns By use of the Padgett dermatome enormous quantities of skin of any thickness desired can be obtained with ease

## BIBLIOGRAPHY


B g d J D d B k C P T tm t f F h T mt d C tam t d W d M t g f Am A o t f S g ry f T m M y 29 30–31 1941

C ld ll G A An Su g **113** 705 (M y) 1941

F t W H W ll m P D W lff R T H t gt E d C l y M L B ll J h H pk H p **67** 427 (D ) 1940

F l d M S E d P t O I J A M A **116** 2641 (J 14) 1941

G d F B d M K m L H Am J S g **51** 584 (M h) 1941

H gh B l S g ry f M d W f E d S L g t Ed b gh 1940 P rt I S I Chap 10

J ks H C A S g **113** 1069 (J ) 1941

J lly D W F ld S g y T t l W H m h H m lt M d l B k Lo d 1940

F ly J F R d l g **20** 296 1933

Lee W E Rh d J E d W lff W A A S g **113** 955 (J ) 1941

L g P H J A M A **116** 2399 (M y 24) 1941

Od lbe g A B t h M d J **2** 43 1940

Orr H W N b k M d J **8** 50 (F b) 19 3

P dgett E C Am J S g **43** 626 (F b) 1939

T eta J Th T tm t f W W l d F t H m h H m lt Med l B k Lo d 1939

W l l y C P G W B S g ry f M d m W f re E d S L g st Edi b rgh 1940 P t I S I Ch p 6

prevention of acute toxemia and sepsis and (3) prevention of scarring

*Burn Shock* —In all burns of any consequence prophylaxis of shock should be instituted when the patient is first seen unfortunately many patients will be in severe shock by the time they reach the hospital Morphine ¼ grain should be given to control pain clothes should be cut away and artificial heat applied In management of the fluid replacement Lee Rhoad and Wolff have found that consecutive determinations of the hematocrit and plasma concentration in patients with extensive burns make it possible to estimate the probable loss of protein from the circulating plasma and to evaluate the ability of the vascular tree to retain added plasma at various times following the injury This abnormal capillary permeability continues for about forty hours By the use of adrenal cortical hormone they have been able to shorten this period by twelve to eighteen hours By means of a combination of *adrenal cortical hormone* and frequent or continuous *plasma infusions* under rigid laboratory control they have carried patients with as much as 65 per cent of the body surface burned through the period of fluid shift Oxygen administered by the Boothby mask is of value also

*Toxemia and Sepsis* —Toxemia and sepsis should be prevented by *proper cleansing* of the burned area and by *early coagulation* The wound should be sponged gently with saline solution it may be necessary to use ether or ether soap to remove grease Blistered and loose skin should be cut away This work should be done under general anesthesia pentothal sodium being an ideal agent The surface may then be coagulated with triple dye (gentian violet 1 400 brilliant green 1 400 flavine 1 1000) or tanning may be produced by tannic acid (5 per cent) alone or in combination with silver nitrate (10 per cent) There are strong advocates for each of these methods under war conditions when the time element is of great importance the tannic acid silver nitrate treatment has the advantage that it produces a good protective coagulum within a few minutes if tannic acid is sprayed on and silver nitrate

Surg al Cl f N th Am ric
D b 1941

# PREVENTION AND TREATMENT OF INFECTIONS IN TRAUMATIC WOUNDS

JOHN S LOCKWOOD M D SC D

M ER C M TTEE O C EM H RA EUTI D O HER A EN A S BCO ITT SU L I FECT N RESEARCH CO NCIL A OCIATE IN S SCHO M CIN UNIV Y PE YL A TA DIRECTO TUM C N H IT U IVER PENNSYL ANIA

---

A GENERAL discussion of the problem of surgical infections of wounds must begin with a consideration of certain fundamental principles which may be said to apply broadly to infection in any re ion of the body A clear understanding of these prin ciples is essential in the intelligent prevention and treatment of infections

When bacteria gain access to subcutaneous submucous or serous tissues the organisms are either destroyed by the forces mobilized by the inflammatory reaction or the organisms be gin to multiply and produce the modifications in the inflam matory response which are characteristic of the different types of infection Bacteria from soil skin clothing or intestine which constitute the primary contaminants in traumatic wounds do not commence to multiply actively for several hours after they gain access to the wound Great advantage may be taken of this fact by the institution of *chemotherapy* of a wounded individual at the earliest possible moment before the bacteria have started to multiply

The *character of the infection* which develops will depend on the following factors (1) the number and invasiveness of the contaminating bacteria (2) the pathologic character of the inflammatory response of the host to the particular type of bac eria concerned (3) the blood supply of the contaminated

F m th H rr so D p tm t f S gical R sea h S h ls f Medi cin I

# PREVENTION AND TREATMENT OF INFECTIONS IN TRAUMATIC WOUNDS

JOHN S LOCKWOOD M D SC D

M ER C MMITTEE CH OTHERA EU N O HER A EN A
S E ON S CAL I ECTIO NA RES ARCH C CIL
A OCIATE IN SUR Y SCHOO O M I IN U IVERSITY PE VL
IA DIRECT TUA C IN H E UNIV IT
PEN YL A IA

A GENERAL discussion of the problem of surgical infections of wounds must begin with a consideration of certain fundamental principles which may be said to apply broadly to infection in any region of the body A clear understanding of these principles is essential in the intelligent prevention and treatment of infections

When bacteria gain access to subcutaneous submucous or serous tissues the organisms are either destroyed by the forces mobilized by the inflammatory reaction or the organisms begin to multiply and produce the modifications in the inflammatory response which are characteristic of the different types of infections Bacteria from soil skin clothing or intestine which constitute the primary contaminants in traumatic wounds do not commence to multiply actively for several hours after they gain access to the wound Great advantage may be taken of this fact by the institution of *chemotherapy* of a wounded individual at the earliest possible moment before the bacteria have started to multiply

The *character of the infection* which develops will depend on the following factors (1) the number and invasiveness of the contaminating bacteria (2) the pathologic character of the inflammatory response of the host to the particular type of bacteria concerned (3) the blood supply of the contaminated

F m th H iso Departm t f S rgical R sea h Schools f Medi
C y f P nsyl ia Ph lad lphia

part and the amount of injured or devitalized tissue in the area The *degree to which the infection extends* either locally or throughout the body will depend on the above factors and al o on (4) the capacity of the immunity re ponse of the individual and (5) whether or not local anatomic barriers are pre ent which will tend to confine the infection within a certain plane or compartment The physician cannot apply in telligent treatment in any infection without takin into con ideration all of the above factors whether the treatment be surgical chemotherapeutic immunologic or a combination of these

### RATIONALE OF THERAPY IN WOUND INFECTIONS

**Surgical Therapy**—Surgery i employed in relation to in fections for the following general purpo es

1 In *prophylaxis* to remove debris and devitalized tissue in order to minimize the number of bacteria and to leave the wound in the best condition po ible for healing Furthermore the conditions for bacterial growth are not nearly o favorable in a wound omprisin only ti sues which are well supplied with blood The di estive proce s by which devitalized ti sue are pontaneously removed from a wound brin about the liberation into the wound of protein plit products which greatly en ourage the survival and multiplication of all types of bac teria It i well kno n that the spores of the gas gangrene-producin organi ms require uch a ound environment in order to develop into virulent vegetative form

2 In *tr at nent* of establi hed infections in order to evacu ate pu to remo e necrotic ti sue and by decompre sion to prevent the pread of exudate under tension along anatomical planes

**Chemotherapy**—Chemotherapy with one of the sulfo namides for example is employed for the follo in eneral purposes

1 In *prophylaxis* to limit the multiplication of contaminat ing bacteria in a fresh wound or destr y them

2 In *treatment* of e tabli hed infect ons to check the rapid ity of growth of bacteria in the body ti sues and fluid thereby

facilitating their destruction by the host and to protect the uninvolved tissues against the spread to them of the infection

**Immunological Treatment** —Immunological therapy in relation to wound infections is employed for the following purposes

1 In *prophylaxis* to provide the patient with neutralizing antibody against certain specific bacterial toxins such as tetanus toxin or the toxin of Clostridium welchii

2 In *treatment* to neutralize bacterial toxins or to augment the effectiveness of the antibacterial mechanisms of the host

In general measures to prevent surgical infections or to treat established infections will involve using a combination of these three types of specific therapy

In the next section I shall discuss the practical application of these considerations to the prevention of infections in traumatic wounds Finally some consideration will be given to the treatment of specific types of infections

## PREVENTION OF INFECTION IN TRAUMATIC WOUNDS

**Sulfanilamide** —The oral administration of an initial dose of 4 to 6 gm of sulfanilamide followed by successive doses of 1 gm every four hours will supply the wound fluids with concentrations of sulfanilamide probably sufficient in the majority of cases to delay or prevent the rapid multiplication in the wound of the primary bacterial contaminants Although this treatment is not by itself sufficient to prevent wound infection it constitutes an important and practical first step Sulfanilamide is recommended at present for this type of prophylaxis because of the relatively low incidence of serious toxic complications attending its use It is not yet certain whether sulfanilamide may be supplanted by one of the newer sulfonamide drugs although the limited experience with sulfadiazine is encouraging

**Excision of the Wound** —The second step in the prevention of infections in traumatic wounds is wound excision or *débridement* This procedure involves the excision under general anesthesia of accessible foreign bodies of bits of clothing and other foreign material and of all tissues which have been

seriously crushed or otherwise separated from an adequate supply of blood As a rule no attempt should be made under emergency conditions to repair nerves and tendons but fractures should be treated as would any open reduction except that primary wound closure is not generally agreed on Serious consequences may follow if damaged muscle which may become necrotic is left in the wound The surgeon should be radical in his removal of this tissue but he may adopt a more conservative policy in excising skin and subcutaneous tissue

The entire procedure should be carried out with strict *aseptic precautions* The surrounding skin should be widely prepared with soap and water benzene and alcohol of 70 per cent (by weight) strength and the patient and all attendants should be carefully masked Special mention is made of these precautions because of the fact that many infections in traumatic wounds are probably due to pathogenic hemolytic streptococci and staphylococci transferred from the respiratory tracts and hands of the medical personnel at the time of operative treatment or postoperative dressing

After wound excision has been completed and hemostasis is effected the wound should be *irrigated* with a considerable volume of normal saline solution applied preferably in a fine stream under pressure through a small nozzle in order to further mechanical separation of bits of blood clot and debris

The operative procedure so conducted will serve to remove most of the bacteria and foreign bodies from the wound and will provide conditions in the wound which will be unfavorable to bacterial multiplication Still further protection against infection may be obtained by applying a thin layer of *powdered sulfanilamid* or *sulfathiazole* to the entire wound surface using approximately 1 gm for each 10 square inches of wound surface Care should be taken to avoid massive aggregations of the powder at any one point because such aggregation may lead to foreign body reaction Not over 15 gm of sulfanilamide should be applied to the wounds of any one patient because the drug is rapidly absorbed and may cause toxic effects if the quantity applied is too great

The wound is then ready for closure if this is technically feasible and not more than six hours following injury have elapsed or for the application of some other type of dressing if closure is impractical

**Wound Dressing and Immobilization**—Under emergency conditions demanding early transportation of individuals with wounds of the extremities the Orr Trueta method of treatment for such cases will be of especial usefulness It involves packing the wound loosely with plain or vaseline gauze and then applying plaster of Paris directly to the skin with padding used only over bony prominences The incidence of serious infections in wounds so treated is reported to be exceedingly low partly because the infrequency of dressings minimizes the secondary introduction of pathogenic bacteria and also because a well immobilized wound tends rapidly to form barriers against spreading infection

When the conditions do not require early transportation of the patient and the facilities of a well equipped hospital are available the surgeon may choose to employ some other method of wound dressing and immobilization in order to permit better control of the fracture if such is present or secondary suture of the wound if no infection develops In such cases *sulfanilamide* or *sulfathiazole* may be reapplied locally to the wound every forty eight hours and if no devitalized tissues are present the development of infection will be unlikely to occur The administration of sulfanilamide by mouth 1 gm every four hours should be continued in all cases of serious injuries for about seven to ten days By the end of that time the wound will probably be healed if successful primary closure was obtained or will be covered by protective granulation tissue if secondary healing is taking place

**Other Preventive Measures**—Other considerations involved in the prevention of infection in traumatic wounds include the following

1 *Tetanus antitoxin* 3000 units should be given after preliminary test of sensitivity accompanied by 1 cc of *tetanus toxoid* (to be repeated on the eighteenth and thirty ninth

days) However if the individual has already received a full course of toxoid immunization only 1 cc of toxoid need be given

2 *Gas gangrene antitoxin* should be given following wound which are probably contaminated with human or animal ex creta such as wounds of the anal region

3 When sulfanilamide cannot be given by mouth it may be given *subcutaneously* The solution is prepared by dissolvin 10 gm of sulfanilamide powder in 1000 cc of normal saline solution which has been previously brought to a boil The total do age parenterally is the same as the total dosage by mouth but interval of six instead of four hours may be used

4 Sulfanilamide may be introduced for prophylactic pur po es into the peritoneal or pleural cavities into joints or ap plied to the brain without interfering with wound healing However the local concentration will only remain in the effec tive range for about forty eight hours Hence it is important to supplement local treatment by oral admini tration

## TREATMENT OF SPECIFIC TYPES OF WOUND INFECTIONS

In all surgical infections it is important to maintain im mobilization with splint or massive dressin and when possible high elevation of the infected part Space will not permit fur ther emphasis of these a d other important therapeutic detail such as good nursing care satisfaction of the fluid and nutri tional requirements of the patient and the prevention or treat ment of shock all of which are indispensable to good sur ery of any type and are not restricted to the domain of surgical infections

**Hemolytic Streptococcal Infections** —*Source* —Droplets from the respiratory passages of medical attendants or of the patient himself are the ch ef source of infection Droplet infec tion may easily be carried n a ward di ectly from one infected wound to another

*Cl nical Cou se* —The nfection m y start in trivial abra sions as well as n la ger wounds The infection i characterized by the early development of signs of lymphatic or blood vas

cular spread *e g* lymphangitis lymphadenitis and chills The entire wound is usually involved and diffuse redness and edema of the subcutaneous tissue are observed Pus is slow to form

*Diagnosis*—The clinical picture will be highly suggestive smear of the wound exudate will show the characteristic organisms as diplococci or short chains Blood culture may be positive very early in the course of the infection

TREATMENT—*Surgical*—Treatment in advance of pus formation should be limited to the removal of any sutures which may have been placed in the wound After abscess formation occurs in the wound or regional lymph nodes drainage should be instituted Exudate which forms in pleural or joint cavities hould be removed by aspiration

*Chemotherapy*—*Sulfanilamide* should be given as follows Initial dose 6 gm followed by 1 gm every four hours day and night until the infection is under control as evidenced by subsidence of fever and local signs Thereafter 1 gm should be given every six hours for about a week Open wounds infected with hemolytic streptococci should be dusted daily with sulfanilamide powder

*Immunotherapy*—If the patient develops a scarlatiniform rash he should receive scarlet fever antitoxin Otherwise serum is of no value

**Staphylococcal Infections**—*Source*—Although staphylococci are widely distributed on the skin and in the respiratory passages many of them are nonpathogenic Contamination with some staphylococci should be expected in every wound

*Clinical Course*—There are two varieties of staphylococcic infection one the highly invasive variety resembles hemolytic streptococcic infection in signs and clinical course and the other a localized type of infection limited perhaps to a stitch hole or to a portion of a wound resemble a localized furuncle In some cases there will occur both a localized carbuncular type of lesion surrounded by an area of cellulitis and a diffuse invasive infection of the blood stream The development of blood stream invasion is frequently associated with thrombophlebitis of a vein draining the primary focus of infection The

days) However if the individual has already received a full course of toxoid immunization only 1 cc of toxoid need be given

*Gas gangrene antitoxin* should be given following wounds which are probably contaminated with human or animal excreta such as wounds of the anal region

When sulfanilamide cannot be given by mouth it may be given *subcutaneously* The solution is prepared by dissolving 10 gm of sulfanilamide powder in 1000 cc of normal saline solution which has been previously brought to a boil The total dosage parenterally is the same as the total dosage by mouth but intervals of six instead of four hours may be used

4 Sulfanilamide may be introduced for prophylactic purposes into the peritoneal or pleural cavities into joints or applied to the brain without interfering with wound healing However the local concentration will only remain in the effective range for about forty-eight hours Hence it is important to supplement local treatment by oral administration

## TREATMENT OF SPECIFIC TYPES OF WOUND INFECTIONS

*In all surgical infections it is important to maintain immobilization with plaster or massive dressings and when possible high elevation of the infected part* Space will not permit further emphasis of these and other important therapeutic details such as good nursing care satisfaction of the fluid and nutritional requirements of the patient and the prevention or treatment of shock all of which are indispensable to good surgery of any type and are not restricted to the domain of surgical infection

**Hemolytic Streptococcal Infections**—*Source*—Droplets from the respiratory passages of medical attendants or of the patient himself are the chief source of infection Droplet infection may easily be carried in a ward directly from one infected wound to another

*Clinical Course*—The infection may start in trivial abrasions as well as in larger wounds The infection is characterized by the early development of *signs of lymphatic or blood stream*

cular spread *e g* lymphangitis lymphadenitis and chills The entire wound is usually involved and diffuse redness and edema of the subcutaneous tissue are observed Pus is slow to form

*Diagnosis*—The clinical picture will be highly suggestive smear of the wound exudate will show the characteristic organisms as diplococci or short chains Blood culture may be positive very early in the course of the infection

TREATMENT—*Surgical*—Treatment in advance of pus formation should be limited to the removal of any sutures which may have been placed in the wound After abscess formation occurs in the wound or regional lymph nodes drainage should be instituted Exudate which forms in pleural or joint cavities should be removed by aspiration

*Chemotherapy*—*Sulfanilamide* should be given as follows Initial dose 6 gm followed by 1 gm every four hours day and night until the infection is under control as evidenced by subsidence of fever and local signs Thereafter 1 gm should be given every six hours for about a week Open wounds infected with hemolytic streptococci should be dusted daily with sulfanilamide powder

*Immunotherapy*—If the patient develops a scarlatiniform rash he should receive scarlet fever antitoxin Otherwise serum is of no value

**Staphylococcal Infections**—*Source*—Although staphylococci are widely distributed on the skin and in the respiratory passages many of them are nonpathogenic Contamination with some staphylococci should be expected in every wound

*Clinical Course*—There are two varieties of staphylococcic infection one the highly invasive variety resembles hemolytic streptococcic infection in signs and clinical course and the other a localized type of infection limited perhaps to a stitch hole or to a portion of a wound resembles a localized furuncle In some cases there will occur both a localized carbuncular type of lesion surrounded by an area of cellulitis and a diffuse invasive infection of the blood stream The development of blood stream invasion is frequently associated with thrombophlebitis of a vein draining the primary focus of infection The

formation of multiple metastatic foci in lungs kidneys and bone is to be expected after bacteriemia but many of the e foci will resolve without formation of pus if the patient recovers

*Diagnosis* —In the case of the localized variety the clinical signs will be suggestive of the type of infection Otherwise the exact diagnosis can be made only by culture of the organisms from the infected wound or from the blood stream

TREATMENT —*Surgical* —The involved portion of the wound should be opened widely and localized abscesses should be drained as soon as the diagnosis of wound suppuration can be made The surgeon should postpone particularly the surgical drainage of abscesses of the face making use of hot wet dres ings to favor resolution In those cases in which extensive ne crosi occurs as in carbuncles complete excision of the lesion may be desirable

*Chemotherapy* —*Sulfathia ole* should be given to every pa tient with a staphylococcic infection which gives evidence of invading either the local tissues or the blood stream An initial dose of 6 gm should be followed by 1 5 gm every four hours until the temperature has been normal for forty ei ht hours Thereafter the dose may be reduced to 1 gm every four hours but in the case of disseminated infections should be continued at thi level for ten to fifteen days or longer Recurrence of infection is l kely if the drug i stopped too soon If facilities for dete mination of the concentration of sulfathiazole in the blood are available and the infection is erious an effort should be made to keep the blood level above 10 mg per 100 cc until the infection is under cont ol u in olutions of od um sulfa thiazole intravenously if eces ary I tho e ca es in which large do es are g en it is important f r the patient to main tain a u ine output of over 1200 cc daily The physician hould watch for oliguria a d other evidences of toxicity

*Open wounds* infected with staphylococci should be treated by applying a thin layer of powdered sulfath azole locally using about 1 gm for each 10 square inches of surface Mo st saline dress ngs should be used on top of the sulfathiazole and

the entire dressing may be changed as seems indicated in the individual case

**Gas Gangrene**—Gas gangrene comprises a group of infections due to Clostridium welchii Clostridium oedematiens vibrion septique and still other anaerobic bacteria

*Source*—The excreta of animals and man and soil or clothing which have been contaminated by such excreta are the principal sources of the anaerobic bacilli which cause gas gangrene While many wounds contain organisms of this group the incidence of actual gas gangrene is limited almost entirely to wounds which contain devitalized muscle tissue The infection after it starts is principally one of muscle bundles The presence in a wound of pathogenic staphylococci or hemolytic streptococci mixed with anaerobes probably favors the subsequent development of gas gangrene

*Clinical Course*—The first sign of the development of gas gangrene in a wound is likely to be the feeling of pain in a hitherto painless wound followed by an abrupt rise in pulse and temperature The wound shows redness edema and severe tenderness and a frothy exudate may appear Palpation or auscultation may reveal crepitation An $x$ ray examination showing gas in the muscle bundles will aid in the diagnosis provided the other signs of the infection are present The infection spreads rapidly unless prompt treatment is instituted and early death from overwhelming toxemia is not uncommon

*Diagnosis*—The diagnosis is made on the basis of the clinical signs described above together with the finding of characteristic rods on smear and anaerobic culture It is advisable whenever possible to determine by guinea pig inoculation the pathogenicity of anaerobes found in wounds which fail to show characteristic signs of infection because many wounds which have been contaminated by feces will show Clostridium welchii even though clinical gas gangrene does not develop

TREATMENT—*Surgical*—Surgical treatment should aim at the opening up of all planes along which the infection has traveled and the excision of *all* infected muscle Amputation need

formation of multiple metastatic foci in lungs kidneys and bone is to be expected after bacteriemia but many of these foci will resolve without formation of pus if the patient recovers

*Diagnosis* —In the case of the localized variety the clinical signs will be suggestive of the type of infection Otherwise the exact diagnosis can be made only by culture of the organisms from the infected wound or from the blood stream

TREATMENT —*Surgical* —The involved portion of the wound should be opened widely and localized abscesses should be drained as soon as the diagnosis of wound suppuration can be made The surgeon should postpone particularly the surgical drainage of abscesses of the face making use of hot wet dressings to favor resolution In those cases in which extensive necrosis occurs as in carbuncles complete excision of the lesion may be desirable

*Chemotherapy* —*Sulfathiazole* should be given to every patient with a staphylococcic infection which gives evidence of invading either the local tissue or the blood stream An initial dose of 6 gm should be followed by 1 5 gm every four hours until the temperature has been normal for forty eight hours Thereafter the dose may be reduced to 1 gm every four hours but in the case of disseminated infections should be continued at this level for ten to fifteen days or longer Recurrence of infection is likely if the drug is stopped too soon If facilities for determination of the concentration of sulfathiazole in the blood are available and the infection is serious an effort should be made to keep the blood level above 10 mg per 100 cc until the infection is under control using solution of sodium sulfathiazole intravenously if necessary In those cases in which large doses are given it is important for the patient to maintain a urine output of over 1200 cc daily The physician should watch for oliguria and other evidences of toxicity

*Open wounds* infected with staphylococci should be treated by applying a thin layer of powdered sulfathiazole locally using about 1 gm for each 10 square inches of surface Moist saline dressings should be used on top of the sulfathiazole and

resort may be made to chemical debridement with *Carrel Dakin technic* This is best employed in the classical manner which requires the careful placing of small perforated rubber tubes throughout the wound and the semicontinuous irrigation throu h them of freshly prepared solution of hypochlorite The surrounding skin should be protected with vaseline gauze and the wound itself covered with a bulky dressing through which pass the rubber tubes

**Burns**—It is not uncommon for infection of the raw sur faces of burns to develop either with or without the use of protective eschars The hemolytic streptococcus is a frequent offender in infections of this sort It has been reported that the topical application of *powdered sulfanilamide* or *sulfa thia ole* in these cases will bring about a rapid subsidence in the signs of acute infection and a disappearance of the or ganisms from the wound The sulfonamide is applied with a salt shaker or insufflator in the amount of 1 gm for each 10 square inches of surface A protective dressing of gauze moistened with saline and covered with vaseline gauze to pre vent drying may then be used This dressing should be changed once daily

Such wounds may be covered with small deep (pinch) grafts as soon as the signs of infection have subsided and the cul tures have become negative for hemolytic streptococcus The ulfanilamide saline dressings are applied directly to the grafts If another type of graft is called for a somewhat longer period of delay will be necessary in order to avoid the possibility of recurrent infection

be done only if necessary in order to remove all of the involved tissue

*Chemotherapy*—Sulfathiazole should be given accordin to the same dose schedule outlined previously for staphylococcic infections

Local Treatment with Zinc Peroxide—The best material for local treatment *after* excision of the involved muscle i *i c peroxide* Medicinal Grade It is suspended in water to form a creamy emulsion and is then used to flood the entire wound A gauze or cotton packing soaked in zinc peroxide cream is then carefully applied to all portions of the wound The entire dressing should be sealed in with ome material which is com pletely impervious to water such as vasel ne gauze in order to prevent drying of the zinc peroxide The dressi ng should be changed every day or two the wound being thoroughly irri gated with saline at each time

*Serum Therapy*—Every patient suffering from gas gangrene should receive an initial dose of about four therapeut c doses of polyvalent antitoxin intravenously diluted in sal ne fol lowed by one or two therapeutic do es every eight hours according to the se erity and course of the infectio Each therapeutic dose contains 10 000 units of Clostrid um welchii antitoxin and variable amounts of antitoxin of the other mem bers of the group

Miscellaneous Infections—*Mix d Infections in Mouth and Jaw Wounds*—Wounds of the mouth and jaws are likely to become infected with anaerobic st eptococci mixed with other anaerob c bacteria which normally inhabit the mouth In the prevent on and treatment of these infections the best agent available at this time for local use is *nc pe oxide* Med icinal Grade It may be used as a mouth wash or as a dressi g (For detail of its use see the section on treatment of gas gangrene)

*Necrot c Slough ng Wounds*—A wound which contains a large amount of nec otic slough will tend to be quite resistant to sulfonamide or nc pe oxide therapy When surg cal re moval of the large masses of infected slough is impractical

# IMPROVISED DRESSINGS AND EQUIPMENT TRANSPORTATION OF THE INJURED

CARLTON L ANDRUS M D F A C S

C D M C U S ES N Y B MED CIN
S GER NA Y DE M W H N D C

---

## IMPROVISED DRESSINGS AXIOMATIC CONSIDERATIONS

It may be well to set forth at the beginning certain axiomatic considerations which are related to the application and use of improvised dressings

1 All body wounds presenting a solution of the continuity of the body tissues in which the skin is involved require dressings

2 A wound dressing includes everything that is used to cover or dress the wound It usually consists of a gauze pad or compress applied directly to the wound and held in place by a bandage

3 Dressings may be applied to wounds as a means of controlling hemorrhage and are used to exclude infection as well as to protect the wound from further injury

4 The pad or compress of a dressing must be sterile

5 Especially prepared sterile dressings or compresses are superior to improvised dressings

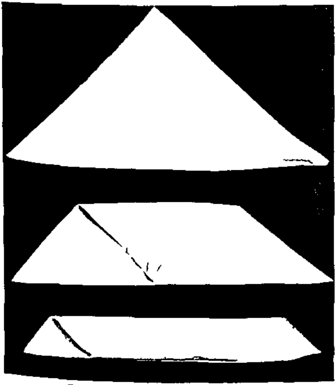
6 Improvised dressings are used only when surgically sterile dressings are not available This implies that improvised dressings are for use in emergency situations

The following considerations must be kept in mind when one is called upon to improvise a dressing in the first aid emergency treatment of any wound

Th p assert t an d h re re th p at es f th er d t t be trued ffi l flect g th e f h N y Departm

quickly improvised from any kind of cloth such as an old sheet shirt neckerchief or tea towel If the material at hand is not large enough to make the bandage full size it can never theless be used by tying available strips of cloth to the ends in order to increase its size

The triangular bandage is made with a piece of cloth 36 to 40 inches square the larger size being preferable for adults



F 374—F ld t f m t ia gl

The quare of cloth i then folded diagonally to make one banda e or may be cut diagonally to make two bandages

The *uses* and *methods of applying* the triangular bandage are de cribed in the Handbook of the Ho pital Corps United States Navy 1939 a follows

The long side of the triangle is called the *base* the point

## TYPES OF DRESSINGS AND THEIR IMPROVISATION

**Pad or Compress** —A pad or compress should be provided Freshly laundered handkerchiefs napkins pillow slips towels or similar articles or materials may be used The cloth should be carefully unfolded and only that part of it that ha not been touched by the hands or any other object should be placed in direct contact with the wound If such materials as tho e mentioned are not at hand take the cleanest cloth available and render it *sterile* by scorching it with a hot iron on top of the stove in the oven over a gas flame or open fire by candle flame matches or other means When this is bein done a certain amount of carbon may collect on the cloth but it will be sterile and not sufficient in amount to harm the wound when the compress is applied

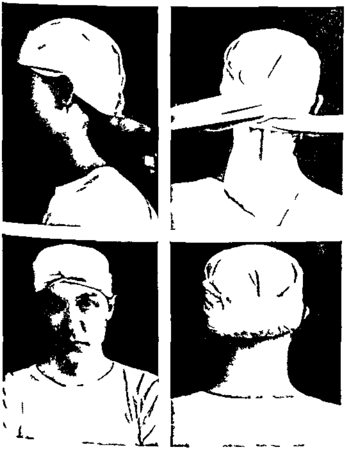
If means are at hand to heat water and time will permit take the most suitable piece of cloth preferably cotton that is *available fold it into a pad of proper size to cover the wound* and *boil* for from ten to fifteen minutes Then wring out as much water as possible unfold to expose an untouched surface and apply directly to the wound

To apply the dressing any one of four type of banda e namely the *roller tr angula fou ta led* or *T bandage* may b used Each type of bandage can be supplied read ly by im provisation and the choice as to which one shall be employed will be determined by the material available the si e and loca tion of the wound

**Roller Bandage** —When a roller bandage is required as the case in wounds of the e tremities it can easily be made by tearin any piece of cloth or garment of clothing that is ava l able such as sheet handke chief or shirt into strips of the desired width A necktie or cloth belt may serve as is in cer tain instances When the strips of bandage mate ial at hand are not of the des ed length two or more pieces can be t ed together by means of the square or reef knot

**Triangular Bandage** —The triangular bandage is of great est value because of its ad ptabil ty to wounds that involve almost any part of the body and because it can be readily and

elbow Drop one end of the triangle over the shoulder on the uninjured side and let the bandage hang down over the chest with the base toward the hand and the apex toward the elbow Slip the banda e between the body and the arm carry the



F 375—F t p t l t gl

lower end up over the shoulder on the injured side and tie the two ends to ether at either side of the neck using a square knot Draw the apex of the bandage toward the elbo until it is nu brin it around the elbow to the front and after fold in back a little fasten it to the front of the banda e with a

*opposite the base is called the apex* and the points at each end of the base are called the *ends* or *extremities* The e bandages may be used either as a triangle or as a cravat the latter bein made from the triangle by brin ing the apex to the base and folding it upon itself a sufficient number of times to obtain the width de ired (Fig 374)

The names of these bandages indicate the part of the body to which the base is applied the location of the apex and the shape For example in the *f onto occipital triangle* the base of a trian ular bandage is applied to the forehead and the apex is carried to the occiput and in the *me ito te tico occipital* cravat the middle of the base is placed under the chin and the end carried over the vertex of the skull to the occ put A few of the more commonly used triangular bandages will now be described

*Fronto Occ pital Triangle*—Place the middle of the base of the trian le on the forehead so that the ed e i just above the eyebrows and bring the apex backward over the head al lowing it to drop over the occ put Brin the ends of the triangle around to the back of the head above the ears cross them over the apex at the occiput and carry them around to the forehead and there tie them in a squa e knot Finally turn up the apex toward the top of the head and pin with a safety pin or turn up the apex and tuck it in behind the cros ed part of the ban dage U e To reta n dres ings on the forehead or scalp (Fi 375)

*Tria igle f Chest Back*—Drop the apex of the triangle over the houlder n the injured ide a d bring the banda e down over the chest (or back) to the level des red and so that the middle of the base is d rectly below the shoulder Carry the end around the body and tie in a square k ot on the back Finally b ng the ape down on the back (or chest) and tie it in a quare knot to one of the ends Uses To retain dressings on burns o wound of the che t or back (Fig 376)

*Brachiocervi cal Triangle o A m Sl ng*—The arm to be put in the sling hould first be bent at the elbow so that the little finger is about a hand s breadth above the level of the

elbow Drop one end of the triangle over the shoulder on the uninjured side and let the bandage hang down over the chest with the base toward the hand and the apex toward the elbow Slip the bandage between the body and the arm carry the

F g 375 —F t pit l t la gl

lower end up over the shoulder on the injured side and tie the two end together at either side of the neck using a square knot Draw the apex of the bandage toward the elbow until it is snug bring it around the elbow to the front and after fold in back a little fasten it to the front of the bandage with

opposite the base is called the *apex* and the points at each end of the base are called the *ends* or *extre nities* These banda es may be used either as a triangle or as a cravat the latter bein made from the triangle by bringing the apex to the base and folding it upon itself a sufficient number of times to obtain the width desired (Fig 374)

The names of these bandages indicate the part of the body to which the base is applied the location of the apex and the shape For example in the *fronto occip tal triangle* the base of a triangular bandage is applied to the forehead and the apex is carried to the occiput and in the *mento ve tico occip tal* cravat the middle of the base is placed under the chin and the end carried over the vertex of the skull to the occiput A few of the more commonly u ed triangular banda es will now be described

*F onto Occip tal Triangle* —Place the middle of the base of the triangle on the forehead so that the ed e i just above the eyebrov and bring the apex backward over the head al lowing it to drop over the occiput Bring the ends of the triangle around to the back of the head above the ears cross them o er the apex at the occiput and carry them around to the forehead and there tie them in a square knot Finally turn up the apex toward the top of the head and pin with a safety pin or turn up the apex and tuck it in behind the crossed pa t of the ban dage L es To reta n dressing on the forehead or scalp (Fi 375)

*Tria i l f Chest or Back* —Drop the apex of the trian le over the houlde on the injured side and b ing the banda e down over the che t (or back) to the le el desired and o that the middle of the ba e i d rectly belo v the shoulder Carry the e d around the body and tie in a qua e knot on the back Finally bring the apex down on the back (or chest) and t e it in a square knot to one of the ends *Use* To retain dressings on burns or vounds of the chest or back (F g 376)

*B ach oc i cal Tr angl or Ar i Slin* —The arm to be put i the sling should first be bent at the elbow so that the little finger is about a hand s breadth above the level of the

apex around the ends of the fingers and over the dorsum of the hand to the wrist or forearm fold each half of the part at

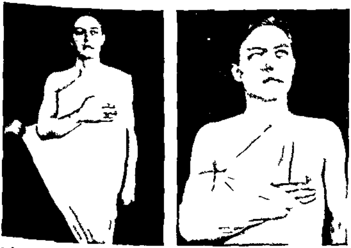


Fig 3 —B h l t gl m h g h g l d p g be t ee m d b d

the ides of the hand back toward the opposite ide of the wri t cross the end around the wri t and tie in a quare knot

safety pin The lower end of the bandage may be passed between the arm and the body and under instead of over the injured shoulder before tying to the other end The end of the

F 3 6 —Tria gl f hest b k

fingers should extend sl ghtly beyond the base of the t ian le (Fi 377)

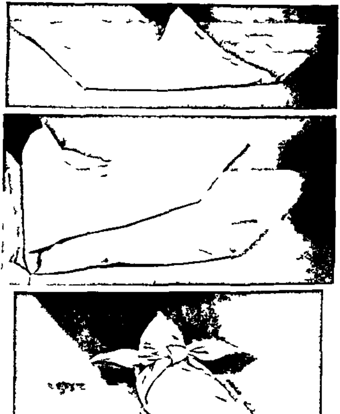
*Triangle of Hand* —Place the middl of the base of the trian le well up on the palmar su face of the wrist carry the

*Triangle of Foot* —Place the middle of the base of the triangle on the ankle well above the heel carry the apex around the ends of the toes and over the dorsum of the foot to the ankle fold each half of the part at the sides of the foot back

Fg 379—T gl f f t

toward the oppo ite side of the ankle cross the ends around the ankle and tie in a square knot Uses To retain dre sings of considerable size on the foot (Fig 379)

*Gluteo femo al Triangle* —To apply thi bandage requires



F 378—T gl f h d

U es To retain dress nos f considerable size on the hand (Fi 378)

as a temporary dressing to ecure fixation of the parts in fracture or di location of the jaw (Fig 381)

*Bis axillary Cravat* —After making a triangle into a cravat of the proper width place the middle of the cravat in the axilla carry the ends upward to the top of the houlder crossing them there and continuin across the back and chest respectively to the opposite axilla where they are tied in a square knot Uses To retain dressings in the axilla or on the shoulder (Fig 382)

Fig 381—M t t capt l cr t

*Cravat of Head or Ear* —After making a triangle into a cravat of the proper width place the middle of the cravat over the point de ired carry the end to the oppo ite side of the head cross them and bring them back to the starting point and tie with a quare knot Use To apply pre sure to control seriou hemorrhage from wound (Fig 383)

The triangular bandage has many other u e in addition to tho e mentioned It application in other type of dre ing to provide traction in fractures of the extremities to hold im

two bandages one a triangle the other a cravat First fasten the cravat around the wai t Place the ba e of the trian le in the gluteo femoral fold and carry the ends around the thigh to the front where they are tied with a square knot The apex is then carried upward and pas ed under the cravat around the

Fg 380—Gl t f m al t gl

wa t turned down and fastened to the t iangle with a safety pin Uses To retain d essing on the buttock or h p (F 380)

*Mento ve t co occ p tal C avat*—Afte makin a trian le into a cravat of the proper w dth place the middle of the cravat under the ch n carry the end up va d in front of each ear to the vertex of the skull cro sing them there and continuing down vard to the oc put whe e they are t d n a square knot Uses To retain d e s n s on the ch n cheeks and scalp and

dre sin in place This bandage is particularly u eful in dress ing wounds of the *chin lower jaw* and *nose*

A similar or many tailed bandage made by splitting the ends of the cloth into several strips equal in number on each side is especially well adapted for dressing wounds of the *abdomen* For thi purpo e the body of the bandage should be placed centrally across the midlumbar portion of the back The tails of the bandage are brought forward over the abdomen and

Fg 383—C t f h d

tied to secure the wound compre s in place If alternate rather than opposite tail of the bandage are tied together the dre in will conform more clo ely to the contour of the abdomen and will remain in place much better

**T Bandage**—The T bandage can be improvised from any available strips of cloth It consists of a horizontal bandage to which i attached about its middle a vertical bandage of ap proximately one half the length of the horizontal one The horizontal portion i employed to ecure the bandage to the body while the vertical portion i u ed to ecure the dressing compress in place

provised splints and to serve as a sling to support the arm are described and illustrated in the First Aid Text Book of the American Red Cross the Soldiers Handbook United States Army and the Handbook of the Hospital Corps United States Navy

**Four tailed and Many tailed Bandages** —The four tailed bandage derives its name from its appearance and is readily

F 382—B ill ry t

improvised from any strip of cloth which is approximately 3 feet long and 2 to 8 inches wide its dimensions dependin upon the size of the wound and the purpose for wh ch it i intended To make it the strip of cloth s spl t len thwi e to with n a few inches of the center thus providing a bandage with a body and four tails The body of the bandage s placed over the pad or compress used in dress n the wound and th tail are carried around the related part of the body and tied to secure the

dressin in place This bandage is particularly useful in dressing wounds of the *chin lower jaw* and *nose*

A similar or many tailed bandage made by splittin the ends of the cloth into several strips equal in number on each side is especially well adapted for dressing wounds of the *abdomen* For thi purpose the body of the bandage should be placed centrally across the midlumbar portion of the back The tails of the bandage are brought forward over the abdomen and

Fg 383—C t f h d

tied to secure the wound compre in place If alternate rather than opposite tails of the bandage are tied together the dressing will conform more clo ely to the contour of the abdomen and will remain in place much better

**T Bandage**—The T bandage can be improvi ed from any available strips of cloth It consists of a horizontal bandage to which i attached about its middle a vertical bandage of approximately one half the length of the horizontal one The horizontal portion is employed to secure the bandage to the body while the vertical portion i used to secure the dressing compress in place

This bandage is especially useful in dressing wounds of the *perineum* and about the *anal opening* When used for this pur pose the horizontal portion is placed around the abdomen above the iliac crests in such a manner that the vertical por tion rests on the midline of the back The vertical portion is brought forward between the thi hs and then upward to be ecured to the anterior horizontal portion of the bandage By longitudinally plitting the free end of the vertical portion of the bandage through about half its length two strip are made which can be carried upward on either side of the external genitalia before being secured to the horizontal portion of the bandage

## IMPROVISED EQUIPMENT

It is recogr ized that especially designed equipment of proved efficiency is superior to that which is improvised Improvised equipment is used primarily to meet emergency situations and should as nearly as possible fulfill the requirements of stand ard equipment The scope of equipment improvisation is limited only by the ingenuity of those called on to utilize what ever material are at hand to meet the need of a given situa tion For the purposes of this paper it is felt that the d scu sion of improvised equipment should be lim ted to those devices that may be employed in the management of wounds and in juries

**Tourniquet**—In the control of hen orrha e from wounds of the extrem ties the necessity may ar se to apply an improvised tourn quet a ound the fo earm a hand breadth belo v the axilla or around the th gh about the same distance belo v the gro n The *Sp t h a ndlass* may be used It cons sts of a flat band of any cloth at least 1 inch wide a piece of rope or wi e is not suitable The triangular bandage folded to form a arrow cravat is ideal for the purpo e b t a belt tocki handker chief o other s milar a t cle can be u ed The tourniquet i applied preferably w th a pad placed di tly o er the brachial or femoral artery b t can b used merely as a constrictin band without the pad In either ca e f the rticle u ed as a bandage i lon enough t should be wrapped around the limb

twice and the ends tied in a half knot Place a short stick bayonet or similar object on the half knot and tie a square knot over that Twist the stick rapidly to tighten the tourniquet until the pressure on the artery stops the flow of blood Do not tighten more than is necessary to control bleeding When the tourniquet has been adjusted hold the stick in position by means of the ends of the bandage already applied or by means of another bandage looped around the end of the stick and secured to the injured limb

The tourniquet is a useful item of equipment but it can also be dan erous It should not be left in place for more than fifteen to twenty minutes without loosening because of the danger that necrosis of the distal part may result if the blood supply i insufficient Do not tighten the tourniquet again unless bleedin persists

**Splints and Traction** —All fractures or suspected fractures of the extremities require the application of splints either with or without traction These should be improvised to suit the needs a determined by the location and type of fracture

FIXED TRACTION —Improvised fixed traction plints may be made from boards about 4 inche wide and ½ inch thick with V notches cut in the end

*Fractures of Lower Extremity* —For fractures of the leg the board should be long enough to reach from about 12 inches above the hip to about 12 inches beyond the foot The method of application is as follows

1 Apply manual traction on the foot

2 Apply traction hitch to foot by placing center of a triangular bandage cravat under center of foot like a stirrup ross the two ends over the instep pass both end back and around behind the foot crossing above the heel and then pass them both forward slipping them under the fir t stirrup loop Maintain traction

Slip a econd cravat under leg until center of bandage is in crotch Tie end above hips in quare knot forming loose loop into which the notch at the proximal end of plint can be placed Again tie end of cravat around plint to hold loop in place

This bandage is e pecially useful in dressing wound of the *perineum* and about the *anal opening* When used for this pur pose the horizontal portion is placed around the abdomen above the iliac crests in such a manner that the vertical por tion rests on the midline of the back The vertical portion is brought forward between the thighs and then upward to be ecured to the anterior horizontal portion of the banda e By longitudinally plitting the free end of the vertical portion of the bandage through about half its length two strips are made which can be carried upward on either side of the external genitalia before being secured to the horizontal portion of the bandage

## IMPROVISED EQUIPMENT

It is reco nized that especially designed equipment of proved efi ciency is superior to that which is improvised Improvised equipment i u ed primarily to meet emergency ituations and should as nearly as possible fulfill the requirements of stand ard equipment The scope of equipment improvi ation is limited only by the in enuity of those called on to utilize what ever material are at hand to meet the needs of a given situa tion For the purpo e of this paper it is felt that the d cus sion of improvi ed equipment should be l mited to tho e devices that may be employed in the management of wounds and in juries

**Tourniquet** —In the control of hemo rhage from wounds of the extremit es the necessity may arise to apply an mprovi ed tourniquet around the forearm a hand s breadth below the a illa or around the thigh about the same di ta ce below the groin The *Spa sh u ndl ss* may be sed It co si ts of a flat band of any cloth at least 1 inch ide a piece of ope or ire is not suitable The t iangular bandage folded to form a narrow cravat i ideal f r the purpo but a belt stockin handker chief or other imilar art cle ca be u ed The to rn quet i applied preferably w th a pad placed d ctly over the brachial or femo al artery but can be sed merely as a co stricting band without the pad In e ther case f the article u ed as a bandage is lon enou h it should be wrapped around the limb

blankets newspapers boards bayonets rifles and similar semi rigid or rigid articles may be used Their uses and methods of application are described in texts on first aid

## TRANSPORTATION OF THE INJURED

The subject of transportation of the injured is exceedingly broad in scope and it will not be possible in this paper to discuss in detail the various means of transportation that may be employed to meet the requirements of widely diversified situations

Transportation of the injured may involve on the one hand the removal of a single individual from the scene of an automobile accident that takes place around the corner from a hospital or it may on the other hand involve the removal of large number of persons from the battlefield to distant hospitals

There are problems in the transportation of patients under conditions obtaining in civilian life problems in the transportation of casualties occurring when the Army is in action and problems in the transportation of tho e injured in a naval engagement

The transportation of these injured may involve travel by land water or air and each will require considerations and facilities peculiar to the situation at hand

Phases of the subject of transportation of the wounded that may stimulate interest in the pertinent studies articles and reports which are available in the literature are the following technic of the hand carry of th injured use of stretchers both regular and improvised and of civilian and military ambulances and other means of transport for the injured in the field various method of shore to ship evacuation during expeditionary operations use of hospital trains ho pital and ambulance ships as well as ambulance and utility planes

It may be observed that such factors as the place conditions under which the injury was received the distance from the scene of injury to the logical destination of the patient the conditions to be encountered during tran portation and the number of persons to be carried all enter into the problems of transportation

4 Tie traction bandage or pieces of small rope to the end of the ankle hitch and pull them downward into the notch at the distal end of the board splint and then upward to take out all slack Next pass the end in opposite directions around the plint and tie firmly with a square knot

5 Insert a strong short stick between the traction banda es distal to the foot and twist until the desired traction is obtained

6 Place any available padding material between leg and plint to relieve pres ure points

7 Apply a suff cient number of wide banda es or cravats around leg and splint from hip to ankle to immob lize the ex tremity

8 The heel of the injured leg should not be allowed to rest on the ground To make sure that it does not the lower end of the splint should be supported from below or held up by a rope loop from above

*Fractu es of Upper Ext emity* —Fractures of the upper ex tremity can be handled in a similar way by applying traction to the hand This is done by roll ng a small stick about 4 inches long into the center of a triangular banda e The rolled up stick i placed in the palm of the hand with fin ers and thumb clo ed around it to form a fist A second cravat banda e is wrapped around the hand and wrist to maintain the hand in the first position The end of the bandage rolled around the stick protrud beyond the thumb and little fin er They are used a traction band They are passed through the notch at the d stal end of the arm pl t and secured Traction can be obtained either by d ect pull or by twi tin stick as is done with the le splint Use no more traction than is necessary

OTHER METHODS OF IMMOBILIZATION —It i the opinion of leading fracture pec al sts i the Un ted States that fixed trac tion is the deal first a d or emerge cy treatment of fractures Cases may ar e howe e in which th ou h inab l ty to obtain the necessary mater al older methods of attempted immobil zation must be employ d a d spl nts appl ed without traction For thi purpo e such improv ed pl ts as pillows folded

# INTRAVENOUS FLUID THERAPY IN SHOCK

NORMAN E FREEMAN M D F A C S

M J Med al Reser e C U S es A y M er S com ittee S oc al R sea C u n A ista Pro so of Re ch S ery H son D ar S r School Med n U ıver ity o P syl ia

Shock is the clinical condition characterized by progressive loss of circulating blood volume resulting from increased capil lary permeability Failure of the peripheral circulation nat urally follows the discrepancy between the size of the vascular bed and the volume of intravascular fluid Thi peripheral circulatory failure leads to capillary stasis tissue anoxia and further increase in capillary permeability Replacement of the ıntravas ular fluid in order to re establish an adequate periph eral circulation becomes therefore the most important fea ture of the prevention and treatment of shock

The volume of fluid contained within the blood vessels is on y about one half of that present in the tissue spaces of the body as a whole and only one fifth as great as that contained w thin the cells of the body It is of vital importance however to maintain constant the volume of fluid within the blood ves sels since the function of all the cells of the body is dependent upo an adequate circulation of blood Under normal condi tions the intravascular fluids are kept constant according to Starling s origin il concept through a balance between the hy d ostatic pressure forcing fluid out of the capillaries and the colloid osmotic pressure of the plasma proteins drawing fluid ırto the blood vessels Examples of this balance are een when the pla ma volume is measured by the dye method during the intravenou injection of a crystalloid (5 per cent glucose solu

F th H so D p tm t f S g l R se h S h l f Med
l rs t f P l Ph l d lph

In the foregoing paragraphs reference has been made to the broader aspects of the subject However certain fundamental considerations that are related to the initial removal of patients from the scene of injury must be dealt with These considerations include the determination of the nature and extent of the injury the adequacy of dressings and splints in immobilizing the injured parts the general condition of the patient the need for care in handling the patient protection and comfort of the patient his covering and the means of combating shock together with reasonable assurance that the patient will arrive at his destination without further injury

Patients who have sustained *fractures* particularly those cases in which bones of the *neck* or *back* are involved require special care and handling while being transported in order to be comfortable and insofar as possible free from danger of further injury If standard equipment is at hand or materials are available for improvisation fractures of the extremities should be immobilized with traction before the patient is transported from the scene of injury A patient who has a fractured neck should be transported lying on his back while the patient with a fractured back should be transported lying on his abdomen In cases in which both neck and back are fractured the patient should be transported as if only the neck were broken If help is available one person should be detailed to watch the patient s head while the patient is being moved

The best method of transporting patients from the scene of injury are by ambulance stretcher Army litter or Navy Stokes stretcher These however are not always available and even if they are they cannot always be used because the access to or exit from the scene of injury will not permit The details of hand carry the various methods of improvising stretchers and detailed descriptions of many different types of especially designed stretchers will be found in texts on first aid in service handbooks and in the literature on the subject

# INTRAVENOUS FLUID THERAPY IN SHOCK

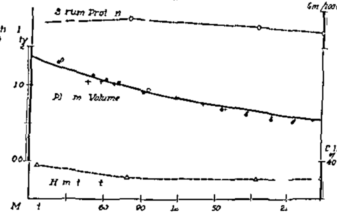
NORMAN E FREEMAN M D F A C S

M jo M c L Reser e Co U it S es A Mes er S b c tte S o k N al R Cou c A n P s f Re a ci S ery H is y D ar s o S Schoo o Med i e U iver y I syl

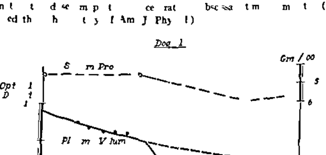
Shock is the clinical condition characterized by progressive loss of circulating blood volume resulting from increased capil lary permeability Failure of the peripheral circulation nat urally follows the discrepancy between the size of the vascular bed and the volume of intravascular fluid This peripheral circulatory failure leads to capillary sta is tissue anoxia and further increase in capillary permeability Replacement of the intravascular fluid in order to re establish an adequate periph eral circulation become therefore the most important fea ture of the prevention and treatment of shock

The volume of fluid contained within the blood vessels is only about one half of that present in the tissue spaces of the body as a whole and only one fifth as great as that contained within the cell of the body It is of vital importance however to maintain constant the volume of fluid within the blood ves sels since the function of ll the cells of the body is dependent upon an adequate c rculation of blood Under normal condi tions the intravascular fluid are kept constant according to Starling s original concept through a balance between the hy dro tatic pressure forcing fluid out of the capillaries and the colloid o motic pre ure of the pla ma proteins drawing fluid into the blood ve els Examples of thi balance are een when the plasma volume is measured by the dye method during the intravenou njection of a cry talloid (5 per cent gluco e olu

F m h H o Departm t f S rgical Rese h School f Med
L t f P l Ph l d lphia




F g 384—C f d sappe f dy T 18 4 f m th blood tre m D g 1 ght 25 kg T ty mg f dy ject d t ly t ze t m th k p t S m p t ce t t d h mat t l f p m t gi t t p d b tt m l h rt l th th f ll g f u es din t rep ese t pt l d ns ty f serum h m t t d se m p t ce rat bsc ssa t m m t (R p ed th h t y f Am J Phy l)




F g 385—Eff t f int inject f 500 f 5 pe t gl se pl m l m se m p t ce d h m D g 1 2 kg (R printed th gh rt sy f Am J Ph l)

tion) or a hypertonic colloid (four times concentrated serum) Figure 384 represents the normal disappearance curve of the dye from the circulation During the intravenous administration of 500 cc of a 5 per cent solution of glucose as shown in Fig 385 the concentration of the dye decreased with a fall in the serum protein concentration and a drop in the hematocrit However almost two fifths of the injected fluid had left the blood stream by the time that the injection was finished since

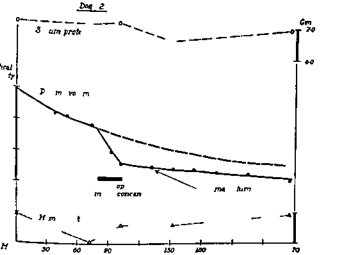



Fig 386—Eff t f t j t f 40 f ly ph l serum h p t t t f 21 6 Gm p 100 pl m l m m p t ce t t d h m t n D g 2 18 Kg (R p ed h gh t sy f Am J Phy l)

the increase in plasma olume was but 330 cc In the succeeding hour another two fifth of the injected fluid containing the crystalloid glucose had left the circulation In comparison Fig 386 shows the sustained decrea e in dye concentration ob erved when a olution of collo d 40 cc of four times concentrated lyophile erum was injected The increa e in plasma volume 143 cc was approximately equivalent to four times the quantity of fluid injected Since the concentration of erum protein wa es ent ally unchanged the injected protein

must have been diluted by fluid drawn into the blood stream from the tissue spaces

### NATURE OF FLUID LOSS ITS REPLACEMENT

Replacement of intravascular fluid must take into consideration the nature of the fluid lost The character of fluid lost will be considered under four categories—water electrolyte plasma and blood

**Loss of Water** —The normal individual who is not exposed to excessive heat loses approximately 1500 cc daily through vaporization from the lungs and skin This amount is increased by fever The loss is in the form of water except under conditions of excessive sweating and should be replaced by givin water without added salts If it cannot be replaced by the taking of food and fluids by mouth it should be replaced by givin 5 per cent glucose solution intravenou ly In the presence of normal kidney function 800 to 1000 cc of urine are sufficient to e crete the waste material The kidney displays a remarkable ability to retain salt if needed so that the amount of fluid lost through urine needs to be replaced simply by water Dehydration is frequently advanced when the patient is first observed Under such circumstance sufficient fluid should be gi en to make up for the amount lo t previously The studies of Coller and Maddock have shown that clinical signs of dehydration are generally present when the patient ha lo t approximately 6 per cent of his body weight Replacement of thi loss should be considered in an estimation of the total quantity which the patient requires

**Loss of Water Plus Electrolytes** —Dehydration is frequently produced by the loss of fluid from the ga tro intestinal tract Since all the secretions of the gastro intestinal tract are approximately isotonic with blood serum (Peters ) replacement of the flu ds lost through vomiting or drainage volume for volume by physiolo ical saline or by Ringer s solution is indicated In order to care for the depletion of salts from which patients are suffering due to the loss of electrolytes prior to observation Coller and Maddock have developed a clinical rule

which states that for each 100 milligrams that the plasma chloride level needs to be raised to reach the normal (560 milligrams per cent) the patient should be given 0 5 gram of sodium chloride per kilogram of body weight

Although the secretions of the gastro intestinal tract are approximately isotonic with blood serum the proportion of ions varies in the different regions Loss of acid gastric contents may lead to serious alkalosis Drainage of secretions from the upper intestinal tract in which large quantities of sodium ions are lost may lead to acidosis The kidney however if it is supplied with an adequate quantity of sodium chloride and water and if it is capable of normal function is able to regulate excretion of the different ions in order to preserve the proper balance

**Loss of Plasma** —By far the most erious loss as far as the production of shock is concerned is occasioned by the loss of fluid with protein This loss is encountered in severe burns crushing injuries of the extremities intestinal distention and any condition associated with injury to the capillaries causing an increase in their permeability Chemical analysis of the fluid lost from the blood stream into the tissue paces after burns and after mild trauma to an extremity has shown that the fluid which accumulates or escapes from the region of injury has essentially the same composition as blood plasma Analysi has not been made of fluid escaping from the capillaries due to a general increase in their permeability such as occurs after prolonged low blood pressure from uncomplicated hemorrhage but the fact that hemoconcentration occurs indicates that fluid plus protein is probably lost from the circulation Replacement of the fluid lost from the blood stream under these circum tances must be made by the administration of fluid containing protein

At the pre ent time the admini tration of pla ma or serum either in the liquid form or redi solved from that dried in the frozen state appear to offer the best olution to the problem pre ented by patients who ha e lo t appreciable quantities of fluid containing protein The importance of having available a pla ma bank can hardly be overemphasized Cro s matching

is not necessary if the plasma from a number of donors is pooled

*Calculation of Plasma Requirements*—The quantity of plasma needed to replace that lost from the blood stream can be roughly calculated from the concentration of the formed elements in case there has not been simultaneous loss of red blood cells Methods have been suggested by Black Elkinton Wolff and Lee and Harkins [1] for calculatin the amount of plasma required in the treatment of severe burns Each of these methods assumes that red blood cells have not been lost The simplest formula is that given by Harkins[1] and is as follows For every point the hematocrit i above the normal of 45 give 100 cc of plasma For children the amount of plasma i calculated proportionately according to body weight with the average adult weight set at 70 kg If the plasma protein level i below normal this method gives too low a value In such a case an additional 25 per cent of the calculated amount of plasma should be added for every gram the protein level is below 6 gm per cent

In case that it is po sible to measure only the hemo lobin concentration the formula of Black may be used

$x$ = amou t f plasma to be gi en in c b ce t meters

$x = (5 - \frac{500}{Hb})\ 1\,000$ here Hb th hemo lob n b erved afte the burn

**Loss of Blood**—The loss of oxygen carrying red blood cells from hemorrhage either through external bleed ng or through loss of blood into traumatized tis ues is not of as great s gnificance in the production of shock as i the lo s of blood volume An effective circulation can be maintained with but 20 per cent of the normal oxygen-carrying capacity of the blood The volume of the circulating blood is far more important since its reduction by as little as 35 per cent may lead to shock

In the treatment of hemorrhage *t ansfusion* of blood is indicated thou h many nvestigators have found that the administration of serum and plasma both normal and concen

trated have been as effective as that of blood Magladery Solandt and Best have emphasized the fact that the volume of red blood cell restored to the animal i more important than their oxygen-carrying capacity

Adequate replacement of blood lost i a difficult matter t judge Since equal amounts of all the elements of the blood are lost in hemorrha e replacement cannot be guided by ob erved alterations in the proportion of the different components The administration of blood pla ma or erum mu t be determined by the clinical condition of the subject and the circulatory re sponse to treatment Criteria of shock are needed to guide in travenous therapy

## CRITERIA OF SHOCK

**Blood Pressure** —Blood pre sure is not in itself a reliable criterion of shock since through va oconstriction the pressure in the larger arteries i frequently maintained in pite of a lowered blood volume and reduced cardiac output John on and Blalock have shown that the cardiac output declines well be fore the blood pressure as shock comes on A reduced blood pre ure in the presence of other signs of shock is of great significance but a normal blood pre sure does not nece sarily signify that the circulation is adequate

**Puls Rate** —The pul e rate is not entirely reliable as a criterion in the primary or neurogenic type of shock the pul e is usually slow Again it may be slow even in the pre ence of severe intraperitoneal hemorrhage (Phemi ter )

**Hemoconcentration** —Hemoconcentration has been ug gested as a diagnostic sign of shock and as a means of differen tiatin this condition from hemorrhage (Moon [7]) Althou h the primary response to hemorrhage i dilution of the blood when shock is produced even by uncomplicated hemorrhage concen trat on of the blood is observed (Blalock Freeman and a so ciates ) In recent investigations on the circulation in shock produced by trauma to the extremitie of dogs under ether anes thesia [8] it was found that concentration of the red blood cell was not significantly increased if there was a considerable lo s

is not necessary if the plasma from a number of donors is pooled

*Calculation of Plasma Requirements*—The quantity of plasma needed to replace that lost from the blood stream can be roughly calculated from the concentration of the formed elements in case there has not been simultaneous loss of red blood cells Method have been su gested by Black Elkinton Wolff and Lee and Harkins for calculating the amount of plasma required in the treatment of severe burns Each of the e method assumes that red blood cell have not been lost The simplest formula is that given by Harkins [1] and is as follows For every point the hematocrit i above the normal of 45 give 100 cc of plasma For children the amount of plasma i calculated proportionately according to body weight with the avera e adult weight set at 70 kg If the plasma protein level is below normal *this method gives too low a value In such a case* an additional 25 per cent of the calculated amount of plasma should be added for every gram the protein level is below 6 gm per cent

In case that it i po sible to measure only the hemo lobin concentration the formula of Black may be u ed

$x$ = amo t f plasma to be given in cub c cent mete s

$x = \left(5 - \frac{500}{\text{Hb}}\right) 1\,000$ where Hb is the h m gl b obs rv d ft r the b rn

**Loss of Blood**—The loss of oxygen-carrying red blood cell from hemorrhage either through external bleedin or through loss of blood into traumatized tissues is not of as great ignificance in the production of shock a i the loss of blood volume An effective circulation can be maintained with but 20 per cent of the normal oxygen-carrying capacity of the blood The volume of the circulating blood i far more important since its reduction by as little as 35 per cent may lead to shock

In the treatment of hemorrhage *transfusion* of blood is indicated though many investigators have found that the admini tration of erum and pla ma both normal and concen

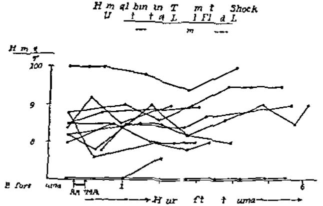
of binding the traumatized extremities i illustrated in Fig 387 It follows then that hemoconcentration is not a reliable criterion of shock in which there is an element of hemorrhage

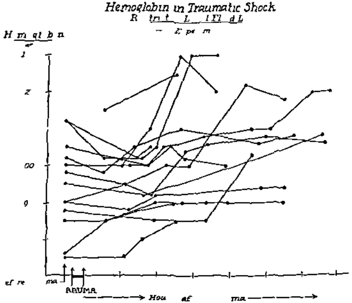
**Reduced Circulation** —A reduction in circulation is probably the most reliable criterion of shock as the investigations of Erlanger Gesell and Gasser disclosed at the close of the last war Studies in clinical cases of surgical shock have confirmed these observations The time relationship between diminished peripheral blood flow reduced blood pressure and hemoconcentration in a series of experiments on traumatic shock[18] is illustrated in Fig 388 As can be seen there was a marked reduction in peripheral blood flow which preceded the fall in blood pressure The rise in hemoglobin concentration occurred only as the blood pressure fell

Clinical methods for measuring the amount of circulation are not available The estimation of peripheral blood flow either by means of the plethysmograph or by the thermo electric stromuhr is not applicable to patients except in research laboratories Determinations of cardiac output either by the Fick principle or by the ballistocardiograph are not readily made Reliance must accordingly be placed upon the clinical signs of reduced circulation as criteria of shock These signs of impaired circulation depend either directly upon the failure of the circulation and the physiological reactions of the body to this condition or upon alteration in the function of various organs produced by failure of the circulation

Clinical Signs of Reduced Circulation —1 The *character of the pulse* is of great significance in the clinical estimation of the condition of shock Its volume probably gives the single best indication of the general condition of the patient The contrast between the full radial artery which indicates an adequate output of the heart and a weak thready pulse of poor volume differentiates a blood pressure associated with a normal cardiac output from an identical blood pressure maintained by peripheral vasoconstriction in the face of a diminished circulating blood volume

2 The *color and temperature of the skin* are also of diagnostic




F gs 387 d 388—C mp f ff t f t d d t ted l cal
fl d l ss h m gl b t t f d gs ft t m t m t

of fluid into the reg on of trauma When the traumat ed l mbs were bandaged so as to prevent the local lo s hemoconcentra tion was obser ed The effect on the hemoglobin co centrat on

dehydration the subcutaneous fluid reservoirs are depleted so that the skin when picked up does not spring back into place but remains in folds The muscles feel doughy to the touch

4 *Restlessness* and *disturbances of sensorium* are frequently encountered and are ominous signs of impending failure

5 *Thirst* is of great significance as a criterion of dehydration shock and hemorrhage unless the electrolytes of the body have been seriously depleted Under the e circumstances even though there i severe dehydration with reduction in plasma volume a condition of li tlessness without much thirst may be observed

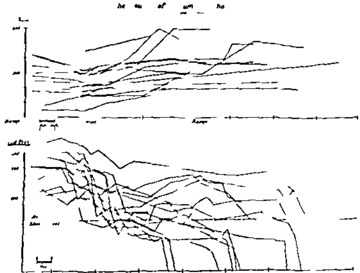
6 The *volume of urine secretion* is frequently of help in following the condition of the patient As Peters has written The patient who is excreting 1000 to 1500 cc of urine daily is seldom a subject for anxiety

## RESPONSE TO TREATMENT

The clinical and chemical response to treatment will determine the course of therapy Frequent measurements of *hematocrit* or *hemoglobin and plasma protein concentrations* will show whether or not the circulation is able to dispose of the fluid administered by vein If both the formed elements and the plasma proteins are being diluted the injected fluid is being retained within the vessels If the hemoglobin concentration is increasing although the level of plasma proteins is staying constant or even decreasing the fluid administered by vein must be leaving the blood stream and restoration of an effective blood volume cannot be attained In the presence of increased capillary permeability whether in a limited region as in case of burns or general as in the shock which follows prolonged inadequate circulation very large quantities of plasma protein will be required to balance the loss

Improvement in the *clinical* condition i equally significant Sustained elevation in blood pressure retardation of pul e rate and e pecially improvement in the quality of the pul e are favorable signs The ces ation of sweating increase of warmth of the extremities and an improvement in color indicate that

importance especially the appearance of the lips the ears the nose and the circumoral region When there is an ashen appearance of the face and the hands are cold and sweaty the process of shock has *reached a crisis which demands interven*



F 3 9—C m| i f l l J fl w l l d j l h m t
l th se f h k

tion Sweating is naturally absent in the shock associated with dehydration

3 The *consistency of the tissues* is related n t only to the water content but al o to the state of the circulation With

dehydration the subcutaneous fluid reservoirs are depleted so that the skin when picked up does not spring back into place but remains in folds The muscles feel doughy to the touch

4 *Restlessness* and *disturbances of sensorium* are frequently encountered and are ominous signs of impending failure

5 *Thirst* is of great significance as a criterion of dehydration shock and hemorrhage unless the electrolytes of the body have been seriously depleted Under these circumstances even though there is severe dehydration with reduction in plasma volume a condition of listlessness without much thirst may be observed

6 The *volume of urine secretion* is frequently of help in following the condition of the patient As Peters has written The patient who is excreting 1000 to 1500 cc of urine daily is seldom a subject for anxiety

## RESPONSE TO TREATMENT

The clinical and chemical response to treatment will determine the course of therapy Frequent measurements of *hematocrit* or *hemoglobin and plasma protein concentrations* will show whether or not the circulation is able to dispose of the fluid administered by vein If both the formed elements and the pla ma proteins are being diluted the injected fluid is being retained within the ve sels If the hemoglobin concentration is increasing although the level of plasma proteins is staying constant or even decreasing the fluid administered by vein must be leaving the blood stream and restoration of an effective blood volume cannot be attained In the presence of increased capillary permeability whether in a limited region as in case of burns or general as in the shock which follows prolonged inadequate circulation very large quantities of plasma protein will be required to balance the loss

Improvement in the *clinical* condition is equally significant Sustained elevation in blood pressure retardation of pul e rate and especially improvement in the quality of the pulse are favorable gn The cessation of sweating increase of warmth of the extremities and an improvement in color indicate that

an adequate circulation is being established Again it should be emphasized that large quantities of blood plasma or serum are necessary As Blalock has expressed it It is not sufficiently appreciated that the introduction of very large quantities of blood may be necessary in order to accomplish the given purpose If it is found that 500 cc of blood is ineffective in maintaining a sustained improvement in the patient it does not follow necessarily that the use of a larger quantity will not accomplish this purpose

## TIME FACTOR IN REPLACEMENT THERAPY

The time factor in the therapy of dehydration and shock is of major importance Replacement of water electrolytes and even plasma and blood is a simple matter before changes in capillary permeability are produced It is agreed by all however *that prolonged impairment of circulation causes an increase in capillary permeability If a state of simple dehydration* is allowed to persist secondary changes take place in the capillaries leading to the loss of plasma protein which will no longer allow recovery with simple replacement of the original fluid lost When shock is present even though only water with electrolytes apparently has been lost restoration cannot be effected by the administration of water with electrolytes alone since the shock produced by the initial loss of body fluid has occasioned further loss of plasma protein Restoration of this secondary loss by the injection of plasma is necessary

*The time factor is also of importance in considering the duration of treatment* Recovery of normal capillary permeability takes time Even after the re establishment of an adequate circulation the blood vessels which have been damaged either directly by anoxia or by some other physical or chemical agent require time for recovery The observations of Rhoads Wolff and Lee suggest the possibility of reducing this period of impaired capillary permeability by the use of the adrenal cortical hormone From the standpoint of intravenous fluid therapy however the implications are clear When the factor of increased capillary permeability is added to the initial loss

of body fluids sufficient plasma protein should be administered in addition to the restoration of body fluids to balance the con tinued loss The circulation must be maintained until recovery of the capillaries can occur

## BIBLIOGRAPHY

1 F m N E d W H W M L Am J Phy 1 124 791 1938
2 C H F A d M dd k W G S g Gy & Ob t 70 340 1940
3 P t J P An S g 112 490 1940
4 G d l S d F J A S g 110 2 1939
5 L d hull F P d F k M E Am J Phy 1 95 330 1930
6 B d J W d Bl l k A A h S g 2 617 1931
7 Bl l k A A h S g 29 837 1934
8 F m N E Sh ff S A S h t A E d H ll g H E J Cl I t 17 359 1938
9 Bl k D A K Brit M d J 2 693 1940
10 Elk t J R W lff W A d L W E A S g 112 150 1940
11 H k H N B h p p d t w th h b t B Sh k M t g f Am M d l A t Cl I d J 2 6 1941
12 B d D D d W ght D G A S g 107 500 1938
13 Le S O N w lt F d N h l H JAMA 114 45 1940
14 M gl d y J W S l dt D Y d B t C H B t M d J 2 248 1940
15 J h so G S d Bl l k A A h S g 23 855 1931
16 Ph m t D B M t f S b mm tt Sh k N t l R C l J 1941
17 M V H A S g 110 260 1939
18 C ll M L S h t A E F m N E d L M K T b p bl h d Bl d S b t t t d Bl d T f C C Th m Sp gfi ld Ill 1941
19 E l g J C H R d G w H S Am J Ph 1 49 90 1919
20 F m N E Sh w J L d S yd J C J Cl I t 15 651 1936
21 Bl l k A Th P pl f S gcal C C V M b C St Lo 1940 p 154
22 Rh d J E W lff W A d Le W E A S g 113 955 1941

# X RAYS IN MILITARY SURGERY

CHARLES F BEHRENS M D

C M C U S ES N U S N H
W HIN Y DC

IN addition to the humanitarian impulse that constitutes a deep activating force in the heart of every true physician and leads him to put forth his best efforts in the behalf of the human wreckage of war there is another and harsher necessity laid upon him in wartime military service namely to keep the maximum number of men in the battle lines Possibly this fact has been emphasized before but it will bear repetition for it is properly a fundamental feature of military surgery Happily the humanitarian and military responsibilities usually go hand in hand save when in the heat of action it becomes more important to return the slightly injured to battle than to attend to serious cases

## HISTORICAL DEVELOPMENT

Certain it is that in dealing with the casualties of war and all the various kindred surgical problems of wartime the $x$ ray is a prime essential Its di covery and utilization was one of the most important milestones in surgical annal and its military importance was promptly recognized In 1897 successful use of the $x$ ray was accomplished in the Graeco Turkish war The Briti h used it on the Indian frontier in 1898 and later somewhat extensively in the Boer War In this country at the outbreak of the Spani h American war the more important Army ho pitals and three hospital ships were equipped with $x$ ray apparatus Seventeen machines were provided in all

At that time construction was in an elementary stage Induction coil and static machines were u ed to activate gas tubes

Th p t ns t d h th pri t f th d t t be trued as ff l reflect g th w f th N v Depa tm t th N l Se ce t l rg

and thereby produce a feeble beam of soft roent en rays Batteries were commonly used or occa ionally direct current from a dynamo was available either to activate a coil or rotate the plates of a static machine Radio raphs were made on glass plate and their production was something of an ab tru e art worthy of the efforts of a crystal gazer so variable and poorly controlled were the factors Exposures were enormous hands one to two minutes shoulders ten minutes and head pelvi and pine about t enty minute It i remarkable that only a few ca es of burns are recorded and al o that creditable work in cluding localization was done Naturally use of roentgen rays near the front line was impossible and in fact decried since it was earnestly felt that its employment there would tempt the more injudiciou and overenthu iast c surgeon to attempt pre mature operation under bad circumstances And in spite of our vastly improved facilities or perhaps becau e of them we can still lend an ear to the e views with profit and apply our best judgment to thi particular problem of how far forward to sta tion roentgenologic units

When almost two d cade later we finally slipped into the vortex of the first World War the mil tary services were not any too well equipped with x ray fac litie as was of course in keeping with the state of unpreparedness generally Only the larger ho pital had roentgenologic units and very few trained roentgenologists were in the active serv ce or reserve corp Thus a weighty problem had to be dealt with without delay and prodi ious efforts were required for its succes ful solution a may be read i an account by Manges Suffice it to say that the radiator type of self ectifying tube was developed gen erators were i ip oved ambulance roentgenologic unit pro ided and chool for roentgenologi ts and technicians estab l hed In all 719 roentgenologic units were sent abroad—a most cred table record

## ROENTGENOLOGIC FACILITIES OF THE NAVY AND ARMY TODAY

As we now prepare ourselves for any eventuality in these troubled days whe i the cla h of a ms a ai fill the world we

find ourselves in a much better situation in regard to roentgen olo ic personnel and equipment

In the Navy for a number of years medical officers have been encouraged to specialize in roentgenology and have been given courses in some of our great civilian medical centers In addition roentgenologists have been enrolled in the reserve corp and are available in case of necessity Training of *tech micians* likewise has not been neglected It has been carried out in our major hospitals and in Washington a twenty weeks course is given to men of proper aptitude In regard to *equip ment* the larger hospitals have full diagnostic facilities and installations for therapy that include 200 kv units Various smaller hospitals and dispensaries have appropriate installa tion hospital ships have facilities for all but deep roentgen therapy Most other ships have either some type of mobile unit or a dental unit In regard to the latter it i surprising what it can accomplish in the way of roentgeno raphy Suitable equipment i also available for expeditionary units

In the Army the story is much the same Its Medical Corps has studied the problem of field equipment with a special thoroughness In general apparatu for use in the field is now far advanced technically It is shock and ray proof of adequate capacity portable durable and easy to assemble and di as semble Processing installations are excellent One is sorely tempted to dilate further on this matter but space forbid

## APPLICATION OF ROENTGENOLOGY TO SURGICAL CONDITIONS

It is only possible to summarize here the subject of the em ployment of $x$ rays in surgical conditions In o doing I have in mind more particularly tho e phy icians who are relatively new to roentgenology or its military applications or perhaps to both

**Fluoroscopy for the Localization and Removal of For eign Bodies** —Pre-eminent among the surgical conditions inci dent to war i the presence of foreign bodies Utilization of $x$ rays for d agnosis localization and aid in actual removal of foreign bodies is inevitable The exact procedure will depend on

a \ariety of factors not the least of which will be limitations imposed by difficult circumstances At times optimal conditions will pre\ail and careful roentgenologic studies of any nature desired will be possible Again circumstances and the urgent pressure of work will impose serious limitations on the roent genologist In general a simple method will often suffice and may be all that i practicable

*Proper Accommodation of the Eyes* —In the performance of fluoro copy a first es ential is proper accommodation of the eyes and regardless of length of experience the roentgenolo t must not start work too soon e pecially when he is con fronted with urgent situations Dark glasses or pectacles kept in readiness for use a ainst sun glare for a preliminary half hour or more are a good investment and will reduce the period in which hea\ier shielding will be a requi ite Needless to say any tendency to night blindne s would render the victim of it a poor fluoroscopist and so the usual dietetic precautions should not be forgotten The diet may be deficient in vitamin A and this deficiency may be entirely unsuspected

*Tecl nic of Remo al* —In emplovment of the simple t pos sible method the operator use a minimal fluoroscopic field centers the object extends forceps down to it seize it and re moves it This procedure sound deceptively s mple but in actual practice trouble i frequently encountered Important structures may be in the way o dan erou ly nearby In this ca e e pecially if the forei n body is ja ed it will be advi able to gra p or approximate the object with forcep then di ect do n to it and o free it safely and e peditiously under good illun ination When such ork is bein pe formed it may be an ad vantage if one member of the operating team keep hi eyes protected during thi final stage In gene al d i on of labor will often be des rable A method found practicable by th French calls for screen g immediately p ior to operation of patients with reta ned f agments Fluoroscopic studies are car ried out with the patient in the anteroposter o posit on An A is marked on the sk n over the fragment Other stud es are made with the patie t in the lateral pos t o an L be n

marked over the fragment When the patient is on the operating table the letters are scratched on the skin with a needle the field prepared and then removal carried out

*Determination of Depth* —At times more elaborate mean of localization will be called for because of the impossibility of extending forceps directly to a foreign body Accurate determination of depth will then be needed The methods employed in general depend on the shift of the image of the object on the fluoroscopic screen or roentgenographic film as the $x$ ray tube is moved Obviously the closer a foreign body is to the tube the greater will be the shift of its image Shift of the tube and image anode screen distance and when required shift in terms of angle can be measured Thus by triangulation the depth of the foreign body can be calculated If the shift is standardized at a fixed distance or angle depth tables can be prepared or a fixed ratio determined for a convenient anode screen (or film) distance so that on determination of the image shift the depth can be read off or calculated immediately For additional details of various methods standard reference and current literature are available

*Nonopaque Objects* —Objects of poor radiopacity are dealt with much easier by roentgenography than by fluoroscopy and careful technic as to roentgenographic density is needed Stereoscopy is often of aid

*Foreign Bodies in the Eye* —With the eye special technic and the use of apparatus such as the Sweet localizer or the contact lens localizer (Pfeiffer) will be needed Difficult cases also bring to mind the fact that it will often be possible under modern conditions to carry out prompt evacuation of casualties by plane to a well equipped base hospital at the rear

*Protection of Personnel* —It appears worthwhile to mention briefly the matter of protection from $x$ ray even at the risk of seeming unduly elementary Roentgenologic apparatus has been vastly improved and will stand enormous punishment but there has been no improvement in the resistance of the human skin nor in systemic resistance to the deleterious effects of roentgen ray Self sacrifice is of course entailed in war but by

care this can be minimized Moreover a technician surgeon or roentgenologist who himself becomes a casualty lose his u efulness and constitutes a liability

Precautions are essential The use of diaphragms to obtain the minimal field practicable gives sharper definition and re duces exposure The hand should be protected by gloves when the conventional heavy gloves are impracticable even light gloves will afford some protection The hands should be kept out of the direct beam—the patient s body should always intervene Other factors are strictest economy in the time the roentgenologic unit is in operation aluminum filtration tests as to degree of exposure by the wearing of dental films checks on the blood count good ventilation of the fluoroscop c room and good personal hygiene In this way much painful and often unnecessary damage can be avoided Unwary individuals still are falling victims to roentgen rays

## X RAYS IN FRACTURES AND DISLOCATIONS

A second hu e class of surgical conditions in which roentgen ology i a prime essential is comprised of fractures and d loca tions Both roentgeno raphy and fluoro copy are needed but in diagnosi it should never be forgotten that the roentgeno ram will reveal more than the fluoroscopic screen and moreover provide a permanent record wh ch can be given meticulous scrutiny In diagnosis of bone condition fluoroscopy i a de ceptive hort cut frau ht with peril and likely to entail more trouble than it will save Also it will occasion more personal expo ure to roentgen rays which i an im po tant con ideration

**Reduction under Fluoroscopic Control**—Reduct on of fractures under fluoroscopic control i often fa ored and at times necessary The ever ncreasing u e of such appliances as the Roger Ande son appa atus to obta n and maintai reduction will tend to increa e the amount f fluoroscopy It is not at all neces ary however no matter hat the vol me of v ork to re ceive exces ive exposure Several mill m te s of aluminum filtra tion can be used and by intelli ent plann and u e of good judgment a very sn all amount f fluoroscopic expo ure will

accomplish all that is necessary On the other hand with care lessness and a heavy foot on the switch damage can result from only a few exposures When reduction is accomplished the end result should by all means be checked roentgeno graphically

**Obscure Fractures in Extremities**—A complete sum mary of fractures is of course impossible and it appears best to touch on some aspects which though apparently minor cause much trouble Injuries to the extremities are of great frequency and all too frequently are attended with undetected fractures which through neglect occasion heavy disability and loss of time Notable in the group is *fracture of the carpal navicular* which as often as not fails to be promptly recognized either throu h failure to make roentgenograms or failure to employ adequate technic The results are deplorable particularly in military service The wrist weakened and painful due to non union of this bone distinctly limits usefulnes of the patient and may keep him on the sick list for months no less surely than a formidable injury that compels attention such as a fractured femur [9] Because of the peculiar curvature of the navicular some modification of conventional technic such as turnin the wrist laterally toward the ulnar aspect or turning the central ray upward at an angle toward the elbow or taking an additional view with the wrist in a slightly oblique position usually will be desirable

Other injuries likely to be mis ed are damage to other car pal fractures of the variou tarsal and metatarsal bones fractures of the intercondylar emin nce of the tibia fractures of the condyloid and coronoid processes of the mandible fractures of the facial bones particularly the zygomatic and compres ion fractures of the vertebral bodies On the other side of the picture care mu t be taken in diagnosing as fractures such conditions as b fid sesamoid acce ory ossicles or growth centers ununited ep ph es or apoph es line due to over lapping bony or even oft tissue margins and variou artefacts and anomal es

**Fractures of Skull**—Skull injur es are grave but there is

practically never any occasion to rush a patient who is in a state of shock or possibly threshing about in delirium into the x ray room to determine the matter of possible skull fracture Fortunately this overpreoccupation with damage to the cranial vault is passing away and less and less of this particular manifestation of poor judgment is encountered *None the less it is worth* mentioning because it is most important because many of us still worry too much about the skull itself and finally because we have to withstand pressure from lay people who do not understand the situation in the slightest way and almost invariably believe that it is a matter of life or death to determine at once if fracture is present

**Other Conditions in Bones and Joints**—In the natural concern with foreign bodies and fractures we must not lose sight of other conditions of the bones and joints They continually obtrude themselves on us and occasion numerous vexatious problems Among these problems complaints referable to the spinal column and extremities are well to the fore Serious disabilities must be detected from the minor the exaggerated and now and then the simulated In making these distinctions roentgen rays are of course indispensable only thus will we sift out conditions such as Pott s disease osteochondrosis *osteochondritis dissecans the para arthritides such as peritendinitis* or bursitis serious sacro-iliac trouble spondylolisthesis retrodisplacement of the fifth lumbar vertebra various anomalies arthritis and bone tumors from the innumerable cases of mere strains sprains and the like with which we are likely to deal summarily It is of course impossible to examine roentgenologically every minor case of trauma but common sense dictates that when pain and disability persist unduly *x ays should b* called for Otherwise grave and humiliating results may be forthcoming

## ROENTGEN THERAPY

Roentgen therapy an important adjunct to surgery In wartime service *furuncles carbuncles* and *cellulitis* occur at least as frequently as in civil life and roentgen rays usually are of great benefit particularly if used early When these infec

tions involve the face roentgen rays may be life savin, *Gas gan rene* also is greatly benefited Large dosage and heavy fil tration are not essential to good results and accordingly the li htest type of apparatus such as a dental unit can be utilized in emergencies A word of caution is necessary about its u e *however* Although it is surely permissible to use such a unit for severe infections it would be folly to use it for the in numerable cases of fungoid infections acne and others such abuse would soon ruin the unit Treatment of numerous cases calls for fairly sturdy apparatus

Another group of frequently encountered infections that is greatly benefited by roentgen rays is comprised of *infections of the middle ear and mastoid process* My experience at the Naval Hospital in Washington extending over ome years in d cates extremely good results and a marked drop in cases that require operations Inasmuch as low or moder ite dosage will nearly always suffice the use of roentgen rays is not completely interdicted if one of the sulfonamide drugs is being given H avy dosage should of course be avoided and those phys icians referring such cases for treatment should inform the ro ntgenologist of the use of these medications and the dosages employed

As a final word on treatment it might be mentioned that plendid results are obtained by the use of roentgen therapy in many cases of so called *subdeltoid bursitis* and kindred con ditions that so often prove re i tant to usual measures Also good re ults are occasionally obtained in cases of severe *strains* and *sprains* that have likewi e proved unduly resistant to treatment

## PHOTOFLUOROGRAPHY

Units for photofluorography (photoroentgenography) have been developed in the Navy following the le d of Dr De Abreu of Brazil [32] s chiefly for chest surveys Improvements and refinements as to technic and material have made po sible ex cellent results thoracic examinations of all recruits are made by means of this method In addition experiments indicate that further expansion o its field of u efulness may be ex

pected Excellent views of bony tructures can be made and such thing as surve of hands and feet may become practical at a minor cost in addition to a certain amount of routine work

Another innovation still in the experimental stage i the application of *lenticulated film* to photoroentgeno raphy By this method it is possible to obtain stereoscopic depth percep tion on a single film and it is hoped accurate depth mea ure ments as well If the method should prove practicable its value to military surgery i obvious We expect to acquire an experimental unit for thi type of work in the near future

## BIBLIOGRAPHY


1 B d W C Th L f th R tg R y by th M dcal D p tm t f th U S A my th W th pain
M g W F M l t ry Roe t l gy Ch pt 10 f R di l gy d t d b Ott Gl sse Ch les C Th m Sprin fi ld Ill
3 M Ca W W R d l gy in th U S Army Am J R tge l & R d Th 45 (5) 33 736 (M y) 1941
4 Le H ry H B ph t m t M m t f D k Ad pt ti m g R tg l g t Am J R t l & R d Th 45 ( ) 753 5 (M y) 1941
5 J ff y J L T tm t f W W ds F I N mb 1940 ss f Ed b gh Med J b t t d B ll tin f W Med N 4 M h 1941 p 13
6 S t S R M l f R tg l l T h q Ed d B th rs A A bo M h 1939 pp 188–193
7 M h ry H W Mod Ph cs f R tg l ry pp 268 27
8 Leddy E re T d Ri F k J Radi d m tits Am g Phy ns Am J R tg l & R d Th 45 (5) 696–700 (M y) 1941
9 H k F ed k R F t f th C p U S N M d B ll 37 (4) 5 3 566 (O t ) 1939
10 P d grass E P d H d P J R tg I diati in th T t m t f I fl mm Am J Roe t l & R d Th 45 (1) 4- 106 (J ) 1941
11 D Ab P ss and App t f R tg Ph t phy Am J R l & R d Th 41 (4) (Ap l) 1939
12 H sch I S th Th U ility f Fl gr phy R d l gy 36 (1) 1 11 (Jan ) 1941
13 Ch mbe W d B h ns C F R Ph t graphy U S N M d B ll 38 (3) (J l ) 1940

# AVIATION MEDICINE

JOHN C ADAMS M D

CAPTAIN M CAL CO U S ES NAVY BU E M CINE
S ERY N D P EN WA RIN T N D C

---

AVIATION Medicine is a development of the first World War It is an inclusive specialty which may be broadly regarded as the application of the medical and allied professions to the problems of the physical and psychogenic stresses encountered in flying For many years its field of activity was largely restricted to military aviation but in more recent years it has been extended to apply to civil aviation as well

There are many physicians whose contact with aviation is limited and who are unacquainted with many of the problems encountered in flying For these reasons the object of this paper is to present a general picture relating to the subject of aviation medicine as a specialty its function and the important role it is required to play in the present emergency but without attempt at detailed discussion of the technical problems encountered in flying

## HISTORICAL DEVELOPMENT

Early in the first World War pilots were poorly selected with regard to their physical and psychological fitness for flying Little was known concerning the stresses peculiar to flying and physical standards were inadequate and poorly adapted to the requirements of aviation For quite some time the principal criteria of fitness for flying consisted largely of the individual s

Th p se t t ed h re th t t f th w t r d t t be d f al flect g b f th N y Dep tm t th N l Service t l rge

willingness to en age in this hazardous vocation There were no pecial provisions to protect pilots from carbon monoxide poi oning due to motor exhaust from anoxia at hi h altitudes from extreme cold noi e vibration and glare There were no pecial provisions or trained personnel for the detection of accumulative fatigue staleness or be innin neuroses amo pilots who showed evidence of deterioration The results were *soon disastrou Casualties due to crashes increased Pilots be* came inefficient and were lo t The neurose and funct onal dis turbances increa ed and even students under instruction de veloped a high percentage of functional nervous disorders This resulted in increa ed failures to qualify in flyin and increa ed numbers of cra hes while pilots were under instruction

Thi situation re ulted in the fir t Special Care of the Flyer Service consi ting of medical officers who devoted their par *ticular attention to the problems described above Spec al* trainin was introduced to qualify medical officers to carry out these duties From thi be inning was evolved the specialty of aviation medicine and with it the name Fli ht Surgeon fo those en aged in this work

Coincident with the e development e tensive re earch was undertaken to acquire more information concernin the effects of *anoxia* on the organi m and explore the role of the *ca dio espirato y system* in flyin especially at h h altitudes Stud es were appl ed to *equ l b ation* and the internal ear The importance of *ac d bas bala ic* and the buffe s at hi h alti tudes unde condition of anoxia was carefully appraised The *pl ysi al standards* for flyi g were completely re ised *Ox en supply apparatus* for use at hi h altitudes was developed and made available Of equal mportance was the ti nely apprecia tion of the *psych log cal str ss* in olved and measu es for deal in with thi problem

Durin the past twenty years the knowledge thus gained has been applied with some advancements but ystemat c and planned research has lagged terr bly We have improved our standard of selection and we ha applied this kno led e to the need of civil aviation as well as to tho e of the military

ervices but we have not kept pace with the new and increased stresses brought about by advancements in aeronautical engineering and desi n

During the first World War planes were slow the rates of climb were slow and ascents seldom exceeded 15 000 to 18 000 feet Today planes often exceed 400 miles per hour in speed Fighter planes come over at 30 000 to 35 000 feet Some planes climb at the rate of about 5000 feet a minute Certain planes have multiple motors and carry large crews and have a cruis in ran e of over 5000 miles Therefore *flyin stress* has increased For instance the oxygen problem is far more complex Old oxygen apparatus and indoctrination are now inadequate and must be completely changed to meet the requirements of extreme altitudes High altitude flights and rapid climb have introduced the new problem of bends or *aero embolism* The cold encountered is more severe and the gravitational tresses encountered in certain aerial maneuver are accentuated As a result of the latter condition the circulation is subjected to such gravity stress that temporary blindne s is produced—the so called *blackout* This is most important in combat flying and dive bombing Experience gained in the present war reveals the importance of special tests for evaluating *dark adaptation* The importance of adequate efficiency in dark adaptation i readily appreciated when we consider the extent of night flight operations now being carried on The truth is the performance of the modern advanced military plane has come to exceed that of the pilot and one of our pressing needs is to devise means of enabling the pilot to catch up with his plane s performance and keep abreast of its further advancements

Aside from the physiological research required to meet the advancing demands of modern aviation the Fli ht Surgeon has a most important role to play in the application of our present knowled e of aviation medicine to the needs of flying as they now exist This function may be roughly divided into

1 Select on f Flyin Pe sonnel
2 Supervi on and Ca f Flyi g Per onn l

willingness to engage in this hazardous vocation There were no special provisions to protect pilots from carbon monoxide poi onin due to motor exhau t from anoxia at hi h altitudes from extreme cold noise vibration and glare There were no pecial provisions or trained personnel for the detection of accumulative fatigue staleness or beginning neuroses amo pilots who showed evidence of deterioration The results were soon di astrous Casualties due to crashes increased Pilots be came inefficient and were lost The neuro es and functional dis turbances increased and even students under instruction de veloped a high percentage of functional nervous disorders This resulted in increased failures to qualify in flying and increased numbers of crashes while pilots were under instruction

This situation resulted in the fir t Special Care of the Flyer Service consisting of medical officers who devoted their par ticular attention to the problems described above Spec al training was introduced to qualify medical officers to carry out these duties From thi be innin was evolved the specialty of aviation medicine and with it the name Flight Surgeon for tho e enga ed in thi work

Coincident ith these developments extensive re earch was undertaken to acquire more information concernin the effects of *a ox a* on the organi m and explore the role of the *card o resp ratory syste n* in flyin especially at h h altitudes Studies were applied to *equilibration* and the internal ear The importance of *a id base bala ice* and the buffers at hi h alt tudes under onditions of anoxia was carefully appraised The *pl ysical sta da ds* for flying were completely revi ed *Oxyg n supply app rat s* for use at high altitudes was developed and made available Of equal importance was the timely apprec a tion of the *psychological st ess* involved and mea ures for deal ing with this problem

Durin the past twenty years the knowledge thu ga ned has been applied with some advancements but systematic and planned research has la ed terribly We have improved our standards of selection and we ha e applied this knowled e to the need of civil aviation as well as to those of the m litary

ervices but we have not kept pace with the new and increased stresses brought about by advancements in aeronautical engineering and design

During the first World War planes were slow the rates of climb were slow and ascents seldom exceeded 15 000 to 18 000 feet Today planes often exceed 400 miles per hour in speed Fighter planes come over at 30 000 to 35 000 feet Some planes climb at the rate of about 5000 feet a minute Certain planes have multiple motors and carry large crews and have a cruising range of over 5000 miles Therefore *flying stress* has increased For instance the oxygen problem is far more complex Old oxygen apparatus and indoctrination are now inadequate and must be completely changed to meet the requirements of extreme altitudes High altitude flights and rapid climb have introduced the new problem of bends or *aero embolism* The cold encountered is more severe and the gravitational stresses encountered in certain aerial maneuvers are accentuated As a result of the latter condition the circulation is subjected to such gravity stress that temporary blindness is produced—the so-called *blackout* This is most important in combat flying and dive bombing Experience gained in the present war reveals the importance of special tests for evaluating *dark adaptation* The importance of adequate efficiency in dark adaptation is readily appreciated when we consider the extent of night flight operations now being carried on The truth is the performance of the modern advanced military plane has come to exceed that of the pilot and one of our pressing needs is to devise means of enabling the pilot to catch up with his plane s performance and keep abreast of its further advancements

Aside from the physiological research required to meet the advancing demands of modern aviation the Flight Surgeon has a most important role to play in the application of our present knowledge of aviation medicine to the needs of flying as they now exist This function may be roughly divided into

1 Selection of Flying Personnel
2 Supervision and Care of Flying Personnel

## SELECTION OF FLYING PERSONNEL

**Physical Standards** —With regard to pilot election undoubtedly the physical standard for flying in our military services are the most exacting of all countries Particular emphasis is placed upon *visual function* and the *cardiovascular system* Military pilots are not only required to have normal visual function but they are al o carefully examined for evidence of any latent defects which under the stress of flying anoxia fatigue and so on might become accentuated and therefore manifest For this reason the eyes are refracted under a cycloplegic The true correction is determined and the eyegrounds are carefully explored The color vision and the peripheral fields of vi ion are subject to special examination The extrinsic muscle balance of the eyes i measured on a phorometer for evidence of any excessive phoria Stereo copic vision is measured as also the accommodative power and the angle of convergence Thi whole array of data is then correlated to fit into an inclusive picture that insures good vi ual function with adequate reserve

Without further regard to the detail of the examination for flying it is sufficient to say that a Flight Surgeon or Aviation Medical Examiner must have a practical workin knowledge of certain aspects of the specialtie of ophthalmology otolaryngology cardiology and psychiatry as well as the basic groundings of the general profession

**Basic Stability and Aptitude** —While we have been able to conduct an excellent e amination on the basi of purely physical criteria this phase of selection alone is of only l mited value The foremost problem today in selection has to do with the evaluation of an ind idual basic stability and aptitude for flying This is a most involved problem Many individual who may be regarded as basically stable may po e s a poor aptitude for flying The effort to develop a method of p ychological and p ychiatrical examination whereby only the good risks are retained and the poor ri ks a e excluded has thus far met *with only limited ucces At p e ent the f nal test* i a try at actual flight trainin where succe s or failure under

actual flight instruction is the deciding factor Where thousands are to receive flight training any large percentage of failures constitutes a serious problem in wasted time and expense and calls for most careful selection However this matter is receiving intensive study and the outlook for improvement is encouraging

Selection of applicants for flying is an important link in our pilot training program and requires the services of a large number of Aviation Medical Examiners especially trained to properly conduct these examinations

## SUPERVISION AND CARE OF FLYING PERSONNEL

Returning now to the care of the pilot it is clear that we are dealing with a highly selected group engaged in a hazardous vocation These individuals are actively engaged in a profession which requires constant vigilance and a high degree of perfection in the performance of their duties It must be clear that even among those pilots of unquestionable skill and maximum adjustment there are always at play the latent *apprehensions of danger* As Armstrong has expressed it Apprehension anxiety and fear are simply three stages of comprehension of danger and it is common knowledge that each results in profound nervous and mental depletion Therefore it is not unreasonable to appreciate some limit in flying time beyond which the most stable person will show evidence of deterioration This limit varies with the individual and considerably so depending upon the nature of the flying performed Generally speaking about eighty five hours in a month is considered as a generous task

**Pilot Fatigue or Staleness**—As previously stated military aircraft are now so advanced that actually they can exceed in performance the capacity of the human element The stresses to which the pilot may be subjected are great When we take into consideration the effect of prolonged noise vibration glare and extreme cold and add to this the emotional stress accompanying such flights we have an explanation for

the first condition frequently to be encountered among aviators namely fatigue

Fatigue a used here does not refer to strictly physical fatigue as normally regarded but to that condition commonly occurring among normal healthy pilots as a re ult of flyin stress It is primarily *neurogenic* and rapidly tend to become *accumulative* It i not measured in dimini hed capacity to do work but rather in the diminished will to work These individuals do not recover their forces in the course of the average rest periods They are tired on awaken n their morale suffers they cease to be alert and they suffer ind fference to details In the course of time they become inefic ent and dangerous *in their flying If neglected the picture pro resses to* profound staleness and in their effort to carry on in the face of a growing sense of inadequacy the syndrome may merge *into a neuro i*

These patients when detected in time promptly respond to physical rest and reasonable relief from flyin Their basic usefulness and attitude toward flyin are not permanently impaired

However when a case of accumulative fati ue or stalene s is neglected or permitted to progress to the point of an established neurosis or the pilot has lost his efficiency and confidence as the result of a prolon ed anxiety state he has usually gone too far for prompt response to treatment and his loss to the flying service i protracted and often permanent

The ea ly manifestat ons of pilot fati ue or staleness are almost invariably subcli cal and eas ly pa s detection The pilot does not apprec ate hi cond tion and under the e circumstance the syndrome may easily progre s to the point where relief from flying becomes neces ary a d protracted The insidiousness of the onset and c rcumstances attending the picture desc ibed are u h that the average clinic an of l ttle value in detectin the e cases

***Functions of the Flight Surgeon*** —E *perience* has shown that in order to establish an early dia nosi of staleness and institute corrective measures t s e sential that the attendin

medical officer shall have a thorough first hand appreciation of the types of stress both physical and emotional that the pilot is subjected to Furthermore and of equal importance the medical officer must know intimately the pilots under his supervision He must be familiar with their private and domes tic problems as well as their professional ones for emotional stress may and often does ari e from these outside sources The medical officer must be thoroughly familiar with the per sonality of each pilot his normal emotional and social tempo for when trouble develops the first indications are minor and insidious changes in these attributes

We may say therefore that an important function of the Flight Surgeon is in a special field of preventive medicine in which psychiatry is the principal guide There are other im portant functions such as the care of the ears the mainte nance of physical fitnes oxygen indoctrination routine care of the sick field supervision and studie dir cted to the im provement of pilot comfort and efficiency

**Facilities for the Training of Flight Surgeons and Aviation Medical Examiners**—To provide these means of trained medical supervision and to qualify officer as Aviation Medical Examiners both the Army and the Navy operate service school devoted to the trainir g of medical officers in the specialty of aviation medicine The ubjects stressed in these schools are ophthalmolo y otology phy iology as applied to aviation cardiology p ychiatry and psychology Laboratory and practical in truction is emphasized In the Navy the course of in truction is extended to include two months of in doctrinal flight training in which the student may be permitted to solo During this phase of training the student en ages in formation flying blind flying catapult shots and torpedo runs The object is to acquaint him at first hand with the different experien es normally to be encountered in flying This com bined training leads to the de ignation of Fl ght Surgeon Officers who complete only the course in aviation medicine but do not take the fli ht ndoctr nal training receive the des ignation of Aviation Med cal Examiner In the Army the sys

the first condition frequently to be encountered among avi ators namely fatigue

Fatigue as used here does not refer to strictly physical fatigue as normally regarded but to that condition commonly occurring among normal healthy pilots as a result of flyin stress It is primarily *n urogenic* and rapidly tend to become *accumulative* It i not measured in diminished capacity to do work but rather in the diminished will to work These individuals do not recover their forces in the course of the average rest period They are tired on awakenin their morale suffers they cease to be alert and they suffer indifference to details In the course of time they become inefficient and dan gerous in their flying If neglected the picture progresses to profound staleness and in their effort to carry on in the face of a growin sense of inadequacy the syndrome may merge *into a neurosis*

These patients when detected in time promptly respond to physical rest and reasonable relief from flyin Their basic usefulness and attitude toward flyin are not permanently impaired

However when a case of accumulative fatigue or staleness is neglected or permitted to progress to the point of an estab lished neurosis or the pilot has lost his efficiency and confi dence as the result of a prolonged anxiety state he has usually gone too far for prompt response to treatment and his loss to the flying service i protracted and often permanent

The early manifestations of pilot fati ue or staleness are almost invariably subcl nical and easily pa s detection The pilot does not appreciate hi condit on and under these cir cumstance the syndrome may easily progress to the po nt where rel ef from flyin becomes nece sary and protracted The insidiousness of the onset and circumstances attending the picture described are such that the average clin cian is of l ttle value in detecting these cases

**Functions of the Flight Surgeon** —E perie ce has shown that in order to establ sh an early dia osi of staleness and in titute corrective measures it i essent al that the attending

medical officer hall have a thorough first hand appreciation of the types of tre s both physical and emotional that the pilot is subjected to Furthermore and of equal importance the medical officer must know intimately the pilots under hi supervision He must be familiar with their private ind domestic problems as well as their professional ones for emotional stress may and often does arise from these outside sources The medical officer must be thoroughly familiar ith the personality of each pilot his normal emotional and social tempo for when trouble develops the first indications are minor and insidious changes in these attributes

We may say therefore that an important function of the Flight Surgeon i in a special field of preventive medicine in which psychiatry is the principal guide There are other important functions such as the care of the ears the maintenance of physical fitness oxyg n indoctrination routine care of the sick field supervision and studies directed to the improvement of pilot comfort and efficiency

**Facilities for the Training of Flight Surgeons and Aviation Medical Examiners** — To provide these means of trained medical supervision and to qualify officers as Aviation Medical Examiners both the Army and the Navy operate service schools devoted to the train ng of medical officers in the speci lty of aviation medicine The subjects stressed in these chools are ophthalmology otology physiolo y as applied to aviation cardiolo y psychiatry and psychology Laboratory and practical instructi n is emphasized In the Navy the ourse of instruction is e tended to include t o months of indoctrinal fl ght training n which the tudent may be permitted to solo During this phase of training the student engages in formation flying blind flying catapult shots and torpedo runs The object is to acquaint him at f rst hand with the different experiences normally to be encountered in flying Thi combi ed train g leads to the designation of *Flight Surgeon* Off cers who complete only the course in aviation *medicine* but do not take the fl ht indoctrinal training receive the designation of Aviation Medical Examiner In the Army the sys

tem of trainin« is slightly different in that following the cour e of academic instruction in aviation medicine the medical offi cer does not receive his designation as Flight Surgeon until he has served a year with the air forces during which time he acquires his flying experience

As can be seen the object i to place medical personnel es pecially trained and with fir t hand knowledge of the stresses encountered in flying in close contact with flyin personnel Experience indicates that only by such means are we able to render the best service to our air forces

### AVIATION MEDICINE IN COMMERCIAL AVIATION

It would not be proper to conclude this subject without fur ther reference to aviation medicine as applied to commercial aviation The role is similar to that for the military services The Civil Aeronautics Administration has e tabli hed physical standard for civilian pilots These vary with the nature of the flying to be performed Accredited medical examiners conduct these examination which are mandatory In addition to these measures all commercial airlines have their own medical di rectors who establish such additional physical requirements as may be considered necessary by their company These airline medical directors and their staffs have made valuable contri butions in the field of aviation med cine It is to them great credit is due for many of the medical safeguard and advance ments directed to improvin passenger comfort in flying

### CONCLUSIONS

From the foregoin it will be een that in time of war or in the event of further extension of our nat onal emer ency phy icians with special trainin« in ophthalmology or psychiatry would be easily adapted to a role in av ation med cine While these two specialties are not the sole requisite for this type of duty they do compri e an acti e field Probably one of the most outstanding requirements for this work i the *pe sonality* of the physician To be a successful Fl ght Surgeon one must be able to convey and invite conf dence Unle s the Fl ht Sur

geon can make himself trusted and liked by his pilots his useful ness is virtually nil except possibly as an Aviation Examiner

Inasmuch as aeronautical performance is constantly pro gressin the need for *physiological research* is most essential as a counterpart This is a field within itself While these studies are intimately related to aviation medicine they are not subject to any limitations The National Research Council is rendering valuable assistance at this time to the aeronautical services as are many scientific institutions and individuals The need for these studies is pressing We are awaiting many answers We have not reached the limits of flying performance and the future has much in store for us At the present time it may be said that further progress in aircraft performance will be of limited value until we can relieve the limitations now confronting the human element

# MILITARY DENTAL SURGERY

Roy A Stout D D S

Lieu C De ( s U ed S A W P
Ge er H pi l W hd DC

## THE MISSION OF THE DENTAL OFFICER AND DENTAL CORPS

The primary mission of the dental officer in the Army is to corre t and maintain the oral health of the military personnel Two important factors in this mission however greatly alter its fulfillment in comparison with similar professional objec tives in civil practice

First the dental surgeon i a Medical Department officer and participate in the general mission of the Medical Depart ment In common with the medical officer he shares in the general medical functions of training in the broad administra tive organization and finally he may participate in many and various medical activities as an auxiliary medical officer

Secondly dental surgery in the military service draws the dental officer clo er to medical and surgical practice both in the dental field and in their general aspects than i experi erced by the civilian dental surgeon in civil practice The or ganization of Army medical installations for war places the dental officer as an integral part of each medical military unit In the tr ining of the personnel of these units to serve com bat troops dental officers must complete an intensive training routine coverin the early care of gunshot wounds ga cas ualties and the great variety of di abilities occurring on the battlefield He must be trained to assi t medical officers in the first aid station casualty clearing stations and ho pital units

Th p asse t t d h th p t f th
w t d t t b t d ff l fl t g th w f th
W D p tm t th m l t ry se i t l g

*Furthermore the dental officer mu t be able to replace medical* officers who may become casualties until medical replacements arrive

Even the primary mission of the Dental Corps expand and moves directly into the field of surgery Confronted with one of the greatest problems of the Medical Departme t the dental officers must clear every mouth of diseased teeth and the universally recognized sources of infection—dental foci In the routine examination of the thousand of cases treated daily in Army *ho pitals close comparison of observations with the* patholo ists and intelligent differential apprai al are both nec e sary to the rendering of final diagno es These relations vi ely developed and thoroughly understood make pos ible a useful and important service in every military ho pital

DENTAL AND ORAL DISEASE

*The approach to surgery may be in the Oral Surgery Service* of the military hospital with its elaborate equipment nurses and other tra ned personnel The dental surgeon on duty here may be solely under the upervi ion of the Chief of Oral Surgery or he may be under the direction of the Chief of Surgery The conditions encountered may be of major cons deration such as o teosarcoma and carcinoma requirin operat ve treatment in the surgical pavil on *In the care of these dental lesions* and of involvement of oral ti sue the dental surgeon carefully trained and di playing surgical di cernment and ntelligent k ll fills an important place in the Medical Department

The trainin and experience of the m litary dental surgeon approach in scope the trainin and expe ience of hi brother medical officer in respect to the necessary medical care of the large and var ed group of cases u der h s care *In fact his* training often places him in a much better position to deter*mine both the medical and surgical care of purely* dental cases The newer methods for the treatment of l cal and general in fections are applied with brilliant results in oral i fections The dental surgeon becomes particula ly interested in the treatment of the more erious ja infections concerning which

he has frequent consultations with the surgical and medical services In the more serious infections involving the head and neck the dental surgeons may be relied upon to aid and assist the military surgeons in their treatment Working together they will try to avoid surgical procedures which might seriously interfere with the normal functions of the dental structures or cause the disfigurement of facial tissues

With this advanced and improved status of the dental surgeon in the military organization it is obvious that his approach to the more common and universal problems of tooth removal eradication of diseased oral tissue and periodontal involvement is more likely to be in keeping with sound surgical principles than it might otherwise be The more desirable methods of surgical removal of teeth and surgical preparation of the mouth for prosthesis not only simplify difficult extractions and conserve tissues but provide for shaping and forming of the ridges for the reception of satisfactory dentures In other words the dental surgeon receives a type of instruction under the Army training program and in accordance with sound surgical judgment that enables him to construct the highest type of prosthetic replacements for the restoration of function

The tissues adjacent to the dental structures unfortunately are susceptible to inflammatory processes to an astounding degree due to faulty care or mutilation of the natural dentition through malocclusion neglect or early loss of individual teeth The various forms of gingivitis traumatic occlusion infections and loss of the vertical dimension of the dental apparatus are but a few of the conditions which affect the dental structures An acute disturbance may yield to simple measures of treatment More frequently the continued irritation of infection leads to a chronic involvement and to the loss of investing soft tissues with disintegration of the bony supporting tissues and loss of the teeth themselves

The dental surgeon must recognize these conditions and initiate the treatment indicated for their elimination The surgical procedures when indicated offer a satisfactory solution in many such cases making possible the retention of many

teeth which mi ht otherwise be sacrificed These are important considerations in the maintenance of the oral health of the military personnel

## RESTORATIVE DENTISTRY

In a great mobilization and trainino program for national defense much attention is devoted to the trainin of dental officers for the purely technical operations of restorative den tistry and for the many aspects of dental surgery The trainin pro rams lead far into the fields of first aid for battle casualtie and the particular and e ential care required for jaw cas ualties In th s training in the dental field e pecially and in the larger field as auxiliary medical officers the instruction and varied training schedules draw the dental surgeon close to the medical officer in his contacts and responsibilities

It is perhaps in the Maxillofacial Service that dental and medical officers are in closest relationsh p havin here many mutual problem in respect to trainin and ultimate duties Refresher courses in plastic and maxillofacial surgery are pro vided for the pecial train n of selected personnel of the Med ical and Dental Corps The objective and purpose of this in struction i to form and prov de *max llofacial teams* trained for this specific sur ical service These skillful dental and general surgeons will be qualified to institute the highly developed type of surgical care required to restore the fac al tis ues and dental function followin injuries and gu shot wound of the face and jaws

A knowledge of urgent fir t aid measures a recoonition of the necessity of the rapid appl cation of bas c principles in early treatment and a profound understa ding of the common problems in every jaw wound are essent als for both medical and dental officers Beyond this i the dominant respo sibil ty of tho e cha ged with the care of the wounded to save life and restore those men who bear the sca s of war to society and lives of usefulness The end results n reconstruct e maxillo facial surgery are directly in proport on to the type of first aid *treatment* and early care rendered by dental personnel in the

combat units and by the maxillofacial teams supporting them in the hospital installations to the rear

All dental officers receive training in the care of jaw casualties and all medical officers and enlisted men with the medical units of the combat organizations are taught first aid measures for jaw casualties With the development of the great training program in the Dental Corps in event of war we should be as confident of proper care and proper first aid treatment of jaw casualties as we are of the proper application of a Thomas splint in the first aid station or casualty clearing station

Dental surgery is directly and firmly associated with the medico military organization Its progress since World War I and its full development within the Medical Department have given it stature and enhanced its value bringing a recognition of its important contribution to the highly developed medical team essential for our Army

# INDEX TO VOLUMES 19 20 and 21

## (1939 1940 and 1941)*

SYMPOSIA

1939

| | |
|---|---|
| *F b* (Ch ca ) | O S |
| *Ap l* (N Y k) | A E D |
| *J* (Lah y Cl ) | Su L T C |
| *A t* (M y Cl ) | D C D B TR |
| *O t b* (Cl la d Cl ) | Di S C O |
| *D b* (Ph l d lphia) | TR W F A |

1940

| | |
|---|---|
| *F b* (Ch cag ) | S A |
| *Ap l* (N Y k) | G IN S |
| *Ju* (Lah y Cl ) | S I A S I |
| *g t* (M y Cl ) | P Po L C |
| *O t b* ( t L ) | C N P M Su D |
| *D mb* (Ph l d lph ) | T T F C G PR |

1941

| | |
|---|---|
| *F b y* (Ch g ) | M S |
| *Ap l* (N Y k) | TR I S |
| (L h Cl ) | D A F C T N N TR |
| *g t* (M y Cl ) | S T M C N |
| *O t b* (Cl l d Cl ) | H M |
| *D mb* (N t d ) | M S R |



N E Th l y g *t lic* typ